Service Manual

# Datascope
# AS3000™

ANESTHESIA DELIVERY SYSTEM

mindray™
NORTH AMERICA

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# Foreword

This Service Manual is intended as a guide for technically qualified personnel performing repair and calibration procedures.

# Warnings, Cautions and Notes

Please read and adhere to all warnings, cautions and notes listed here and in the appropriate areas throughout this manual.

A **WARNING** is provided to alert the user to potential serious outcomes (death, injury, or serious adverse events) to the patient or the user.

A **CAUTION** is provided to alert the user to use special care necessary for the safe and effective use of the device. They may include actions to be taken to avoid effects on patients or users that may not be potentially life threatening or result in serious injury, but about which the user should be aware. Cautions are also provided to alert the user to adverse effects on this device of use or misuse and the care necessary to avoid such effects.

A **NOTE** is provided when additional general information is applicable.

# Warnings

**WARNING: Whenever using anesthetic gases, nitrous oxide, oxygen, or any hospital gas always follow the appropriate agent evacuation/collection procedures. Use the hospital gas evacuation system.**

**WARNING: For continued protection against fire hazard, replace all fuses with the specified type and rating.**

**WARNING: In order to prevent an electric shock, the machine (protection class I) may only be connected to a correctly grounded mains connection (socket outlet with grounding contact).**

**WARNING: Remove all accessory equipment from the shelf before moving the anesthesia machine over bumps or on any inclined surface. Heavy top loading can cause the machine to tip over causing injury.**

**WARNING: Possible explosion hazard. Do not operate machine near flammable anesthetic agents or other flammable substances. Do not use flammable anesthetic agents (i.e., ether or cyclopropane.)**

**WARNING: The use of anti-static or electrically conductive respiration tubes, when utilizing high frequency electric surgery equipment, may cause burns and is therefore not recommended in any application of this machine.**

**WARNING: Possible electric shock hazard. The machine may only be opened by authorized service personnel.**

**WARNING: Compressed gasses are considered Dangerous Goods/ Hazardous Materials per I.A.T.A. and D.O.T. regulations. It is a violation of federal and international law to offer any package or over pack of dangerous goods for transportation without the package being appropriately identified, packed, marked, classified, labeled and documented according to D.O.T. and I.A.T.A. regulations. Please refer to the applicable I.A.T.A. Dangerous Goods Regulations and /or the Code of Federal Regulations 49 (Transportation, Parts 171-180) for further information.**

**WARNING: Avoid exposure to respiratory gases by always directing the fresh gas flow from the fresh gas outlet to the waste gas scavenger.**

# Cautions

**CAUTION: This device uses high pressure compressed gas. When attaching or disconnecting backup gas cylinders, always turn the cylinder valves slowly. Use the AS3000 flow meters to bleed down the pressure, watching the cylinder gauge indicate the depleting cylinder pressure, before disconnecting the cylinder from the yoke. Always open and close cylinder valves fully.**

**CAUTION: This device operates using compressed gas at high pressures from the hospital central supply. When connecting gas supply lines attach the hose connection to the machine before connecting the quick disconnect fitting to the hospital source. Disconnect the supply hose from the hospital source connection prior to disconnecting it from the AS3000 gas connection fittings.**

**CAUTION: Refer to the "Periodic Maintenance Schedule of Service Activities" on page 6-2, in the Periodic Maintenance section for assistance when performing scheduled periodic maintenance.**

**CAUTION: Do not leave gas cylinder valves open if the pipeline supply is in use and the system master switch is turned to 'ON'. If used simultaneously, cylinder supplies could be depleted, leaving an insufficient reserve supply in the event of pipeline failure.**

**CAUTION: Use cleaning agent sparingly. Excess fluid could enter the machine, causing damage.**

**CAUTION: This machine must only be operated by trained, skilled medical staff.**

**CAUTION: Perform the electrical safety inspection as the last step after completing a repair or after routine maintenance. Perform this inspection with all covers, panels, and screws installed.**

**CAUTION: After changing the $CO_2$ absorbent, carry out a system leak test.**

**CAUTION: Only Selectatec™ compatible vaporizers with Interlock-System may be used with the AS3000 unit.**

**CAUTION: After each exchange of a vaporizer, carry out a system Leak test.**

**CAUTION:** **The bellows dome cannot be autoclaved.**

**CAUTION:** **Do not clean the machine while it is on and/or plugged in.**

**CAUTION:** **Pressing "Quit" at any time during the procedure will cancel the session's settings and reload the previously-stored calibration coefficients.**

**CAUTION:** **Depleted soda lime changes color. Replace the soda lime if approximately 2/3 of the absorber content is discolored. $CO_2$ absorbent can be safely changed without stopping mechanical ventilation.**

# Notes

**NOTE:** **Unauthorized servicing may void the remainder of the warranty. Check with the factory or with a local authorized distributor to determine the warranty status of a particular instrument.**

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# 1.0 *Theory of Operation*

## 1.1 Introduction

The **AS3000** is a continuous flow anesthesia system which offers manual or automatic ventilation, easily adjustable fresh gas delivery, anesthetic agent delivery, ventilation monitoring, convenient ergonomics, and state-of-the-art safety systems. The components of the **AS3000** Anesthesia System are described this chapter.

# 1.2 Microprocessor-controlled Ventilator

The Microprocessor-controlled ventilator, with its dedicated Breathing System, allows time-controlled, pressure limited, constant volume ventilation for all patient groups within a tidal volume range of 40 mL (4 kg infant) to 1400 mL (large adult).

Time-controlled, pressure limited, and compliance compensated constant volume ventilation is provided through the Controlled Mandatory Ventilation (CMV) mode. The CMV mode delivers a viable ventilation method for complicated lung conditions. The ventilator also provides time-controlled, volume dependant ventilation, targeting a set (adjustable) target pressure provided through the Pressure Controlled Ventilation (PCV) mode. Automatic and comprehensive system startup tests and alarm management systems ensure controlled ventilation conditions in every mode of operation.

The durable and ergonomically designed user interface and Navigator™ Knob enables easy operation. The display provides the selected ventilation modes (CMV, PCV, PS and SIMV) and the following values: Tidal Volume, Peak Pressure, Mean Pressure, $FiO_2$, Breath Rate, I:E Ratio, PEEP, Plateau Pressure, Alarm limits, and real-time Airway Pressure and flow waveform.

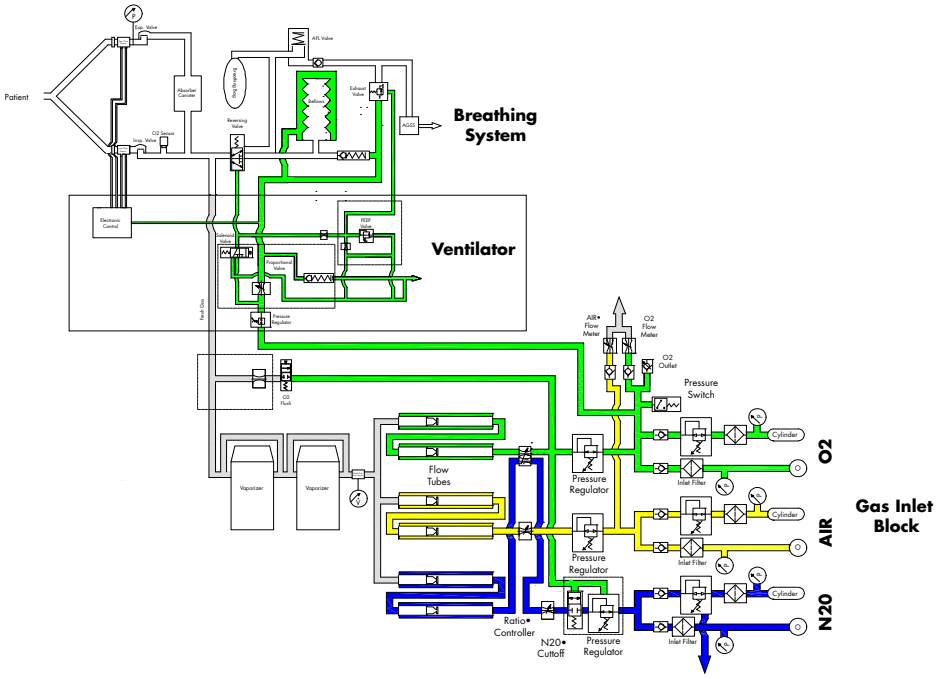


**FIGURE 1-1** The **AS3000** Pneumatic System

# 1.3 Components

## 1.3.1 Front View

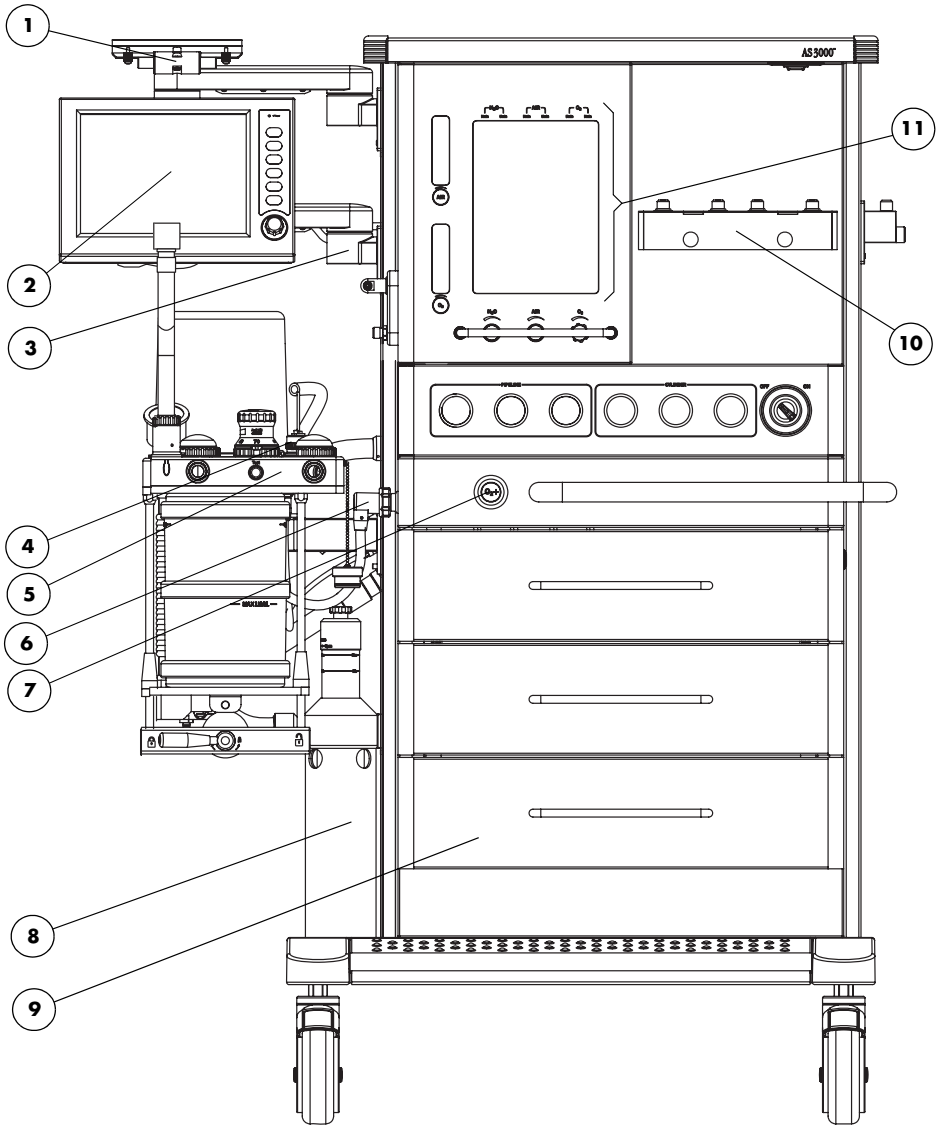


**FIGURE 1-2 AS3000** Front View

### 1. Monitor Arm

The Monitor Arm provides support for a bedside monitor. It can easily rotate for more convenient viewing.

### 2. User Interface

The display of the user Interface provides waveforms, numeric data and menu tabs. The keys and Navigator Knob enable the user to power up the system, silence alarms, access menu tabs, and switch between manual and mechanic ventilation.

### 3. UI Arm

The UI Arm provides support for the user interface assembly. It can easily rotate for more convenient viewing.

### 4. Oxygen Sensor

The Oxygen Sensor monitors the oxygen concentration of the inspired gas of the Breathing System.

### 5. Breathing System

The Breathing System's main function is to store anesthetic gas, oxygen, and air; vent exhaust gas; and absorb carbon dioxide. It connects directly to the respiratory passage to help complete the breathing process.

### 6. CGO (Common Gas Outlet) Subassembly

Mixed gas composed of $O_2$, AIR, $N_2O$, and anesthetic agent connects to the patient's Breathing System via a flexible tube from the CGO Subassembly.

### 7. $O_2$ Flush Valve

The $O_2$ Flush Valve is located on the front of the **AS3000**. The supplied gas does not pass the flowmeter and vaporizer. It is directly sent to the fresh gas outlet. Press this button to supply gas (35 - 50 L/min). Release this switch to automatically close the gas supply.

### 8. AGSS (Anesthetic Gas Scavenging System)

The AGSS (Anesthetic Gas Scavenging System) reclaims exhausted gas generated during anesthesia.

### 9. Drawer Subassembly

The **AS3000** has three drawers for storage, which can be locked and fixed through the uppermost drawer lock.

### 10. Vaporizer Mounting Manifold

The Vaporizer Mounting Manifold provides support for up to two Selectatec® compatible anesthetic vaporizers.

### 11. Flowmeter

The Flowmeter displays gas flow values for $N_2O$, $O_2$, AIR, Auxiliary $O_2$, and Auxiliary AIR. It consists of coarse and fine flow tubes used to accurately measure gas flow with additional flow tubes to measure auxiliary $O_2$ and AIR gas flow.

Flow tube measurement values:

| GAS | FINE FLOW TUBE | COARSE FLOW TUBE -01 UNITS | COARSE FLOW TUBE -02 UNITS | AUXILIARY FLOW TUBE |
|---|---|---|---|---|
| $N_2O$ | 0 - 1 L/min | 1 - 12 L/min | 1 - 10 L/min | N/A |
| $O_2$ | 0 - 1 L/min | 1 - 10 L/min | 1 - 10 L/min | 0 - 15 L/min |
| AIR | 0 - 1 L/min | 1 - 15 L/min | 1 - 12 L/min | 0 - 15 L/min |

## 1.3.2 Side View

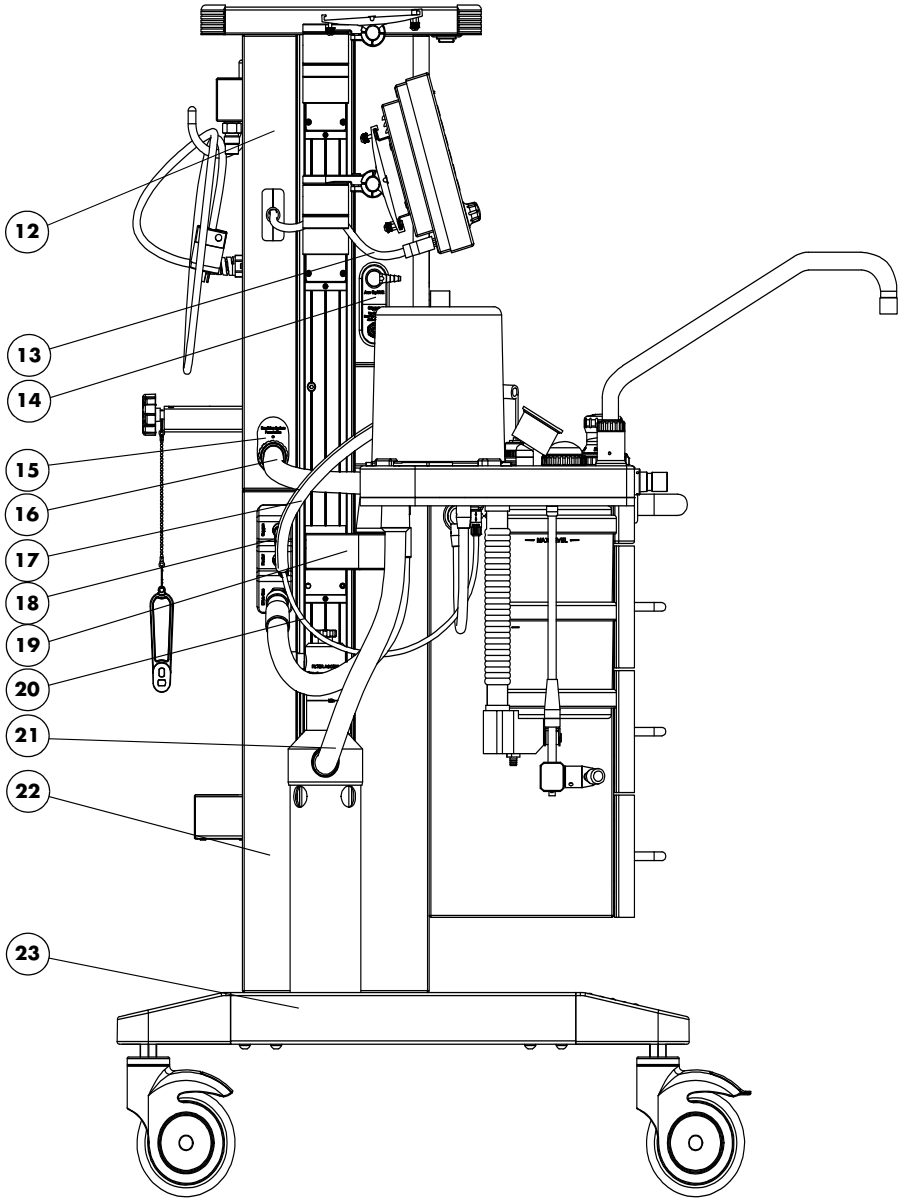


**FIGURE 1-3 AS3000** Side View

### 12. Upper Mainframe Subassembly

The Upper Mainframe Subassembly provides support for the pressure gauges, the Flowmeter, the gas box assembly, the mains supply assembly, and the YOKE assembly.

### 13. User Interface Cable

The User Interface Cable provides signal transmission between the User Interface and the main unit.

### 14. Auxiliary Gas Outlet Assembly

The Auxiliary Gas Outlet Assembly provides the patient with auxiliary oxygen and air mixtures (of different concentrations). It also contains an $O_2$ connection for use with other equipment.

### 15. Breathing System Interface

The Breathing System Interface provides a connection interface for gas signal acquisition between the Breathing System and gas circuit.

### 16. Breathing System Pneumatic Hose

The Breathing System Pneumatic Hose provides multiple connections including: PEEP control, Auto/Manual control, and four pressure sampling connections between the Breathing System and mainframe.

### 17. $O_2$ Sensor Cable

The $O_2$ Sensor Cable provides a connection between the oxygen sensor component in the Breathing System and the oxygen concentration signal acquisition port on outlet module of the mainframe.

### 18. Breathing System Interface

The Breathing System Interface provides the main unit with an interface for connection with drive gas, heating system and the oxygen concentration sensor of the Breathing System.

### 19. The Breathing System Support Arm

The Breathing System Support Arm provides connection between the Breathing System and the mainframe, in order to support the Breathing System.

### 20. Heater Wire

The Heater Wire provides connection to the heating system of the Breathing System. By heating the Breathing System during anesthesia, accumulation of water in the Breathing System is minimized. It also provides comfortable gas to the patient.

### 21. AGSS Transfer Hose

The AGSS Transfer Hose provides pipeline connection between the exhaust gas outlet of the Breathing System and the AGSS evacuation system.

### 22. Lower Mainframe Assembly

The Lower Mainframe Assembly provides support for the drawer subassembly, outlet module, CGO subassembly, $O_2$ flush valve and the electric box. Together with the Upper Mainframe Subassembly and Base Assembly, forms the mainframe of the machine.

### 23. Base Assembly

The Base Assembly provides support to the whole machine. The four casters provide movement for the machine in any direction. The front casters have a locking function.

## 1.3.3 Rear View

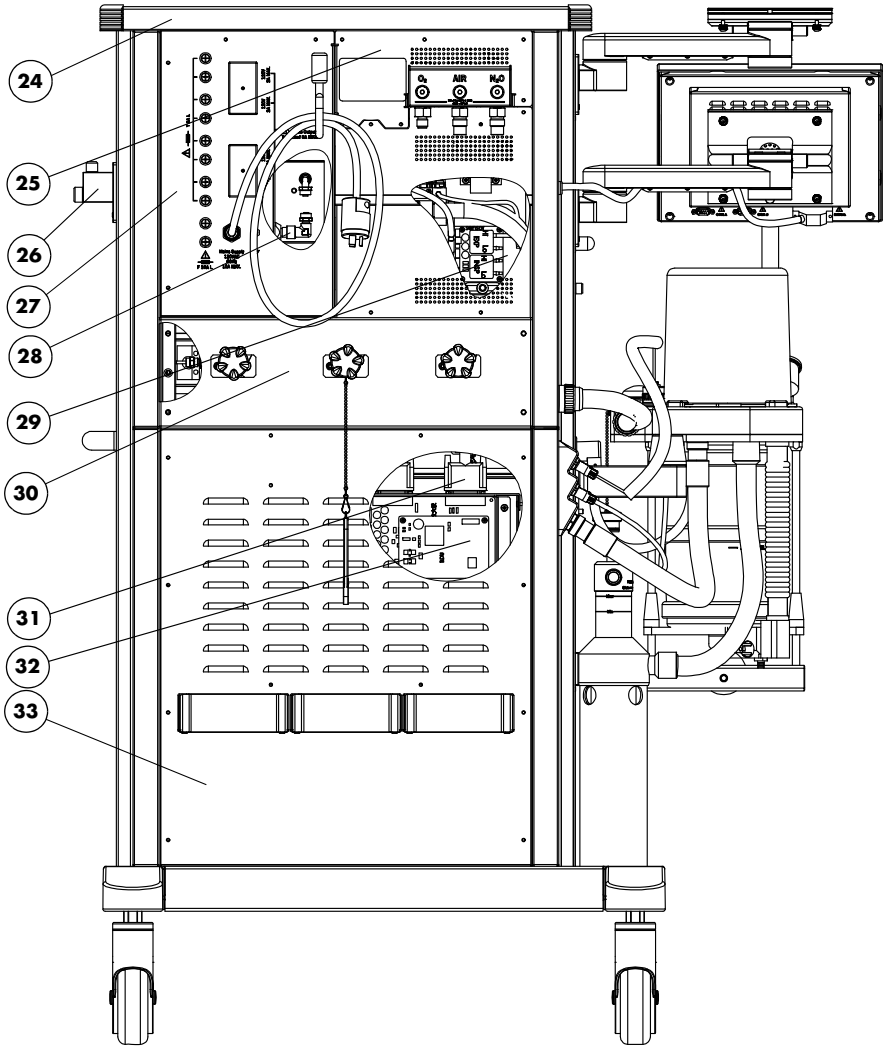


**FIGURE 1-4 AS3000** Rear View

### 24. Top Shelf Assembly

The Top shelf Assembly includes the work light and its switch. It also serves as a storage area.

### 25. Gas Input Assembly

The Gas Input Assembly allows gas in the pipeline and backup gas cylinder to enter the **AS3000** for regulation. The Pressure regulator reduces pressure to 36 psi (250 kPa). The $O_2$ operated valve can open allowing $N_2O$ to enter the flowmeter only when $O_2$ pressure is above 7.3 psi (50 kPa). Otherwise, $N_2O$ cannot enter the gas circuit. The pressure switch generates a signal when the input pressure is below 29 psi (200 kPa), and the system will provide an audible alarm.

**26. Vaporizer Storage Mount**

The Vaporizer Storage Mount provides the **AS3000** with auxiliary placement for a vaporizer.

**27. Mains Supply Assembly**

The Mains Supply Assembly attaches the **AS3000** to an external AC wall outlet. It also supplies power throughout the unit.

**28. Electronic Flowmeter Assembly**

The Electronic Flowmeter Assembly provides fresh gas flow measurement for the **AS3000**.

**29. Gas Box Assembly**

The Gas Box Assembly provides drive gas to the Breathing System and includes a safety valve to insure that pressure stays below 85 $cmH_2O$. It also contains the PEEP valve, and the differential pressure sensors.

**30. YOKE Assembly**

The YOKE Assembly provides connection for three backup gas cylinders. The pressure regulator for the backup gas cylinder reduces the pressure of a high pressure gas cylinder down to 43.5 psi (300 kPa).

**31. AMP Cables**

The AMP Cables provide signal transmission between the electric box and gas circuit box.

**32. Electric Box Assembly**

The Electric Box Assembly provides, and distributes power to the **AS3000.**

**33. Rear Panel Assembly**

The Rear Panel Assembly protects, and provides heat dissipation for the electric box and auxiliary support for the backup gas cylinder.

## 1.3.4 Other components (not identified in graphics)

**34. Inspiratory and Expiratory Valves**

The Inspiratory and Expiratory Valves are unidirectional valves that allow air to flow in only one direction.

**35. Absorber Canister**

The **AS3000** uses two Absorber Canisters which can contain 1500 mL of soda lime each. They can be used for 6 - 8 hours each if full. Water generated from the reaction with $CO_2$ is drained from a valve on the lower side of the canister.

**36. APL (Airway Pressure Limiting) Valve**

The APL Valve is used for limiting maximum airway pressure during manual ventilation. The adjustable range of the APL is 0 - 70 $cmH_2O$.

**37. Bellows Assembly**

The **AS3000** employs ascending ventilation bellows, in which mixed gas is stored. Drive gas supplied by the ventilator forces the bellows to descend sending mixed gas into the inspiratory passage of patient's airway. If a patient's airway suffers from gas leakage, the bellows will collapse, informing the operator of a possible problem. A tidal volume scale is provided on the transparent dome, through which a patient's tidal volume can be estimated.

**38. Pressure-relief Valve**

The Pressure-relief Valve is located at the base of the bellows. When end-expiration airway pressure reaches 1 - 3 $cmH_2O$, the pressure-relief valve opens and redundant gas is expelled.

**39. Exhaust Gas Outlet**

The Exhaust Gas Outlet is located on the lower part of the Breathing System. It is connected to the AGSS or via the AGSS transfer tube.

**40. Absorber Heating System**

The Breathing System is heated to body temperature to avoid humidified gases condensing within the Breathing System thus improving airway climatization for the patient's re-breathing of respiratory gases.

## 1.3.5 Breathing System

The Breathing System is integrated into a compact aluminum block. This block is heated to body temperature to prevent condensing of humidified gases within the Breathing System, thus improving airway climatization for the patient's re-breathing of respiratory gases. The heated Breathing System contains: an inspiratory valve with $O_2$ adapter for $FiO_2$ measurement, expiratory valve, APL Valve, breathing bag connection, and internal inspiratory and expiratory flow sensors.

## 1.3.6 The Ventilator Unit

The **AS3000** ventilator offers multiple ventilation modes: Controlled Mandatory Ventilation with volume control (CMV), Pressure Control Ventilation (PCV), Synchronized Intermittent Mandatory Ventilation (SIMV), and Pressure Support (PS) ventilation. Electronic PEEP is available in all ventilation modes. User control over inspiratory flow (SLOPE) is possible in PCV, SIMV, and PS modes. Automatic fresh gas compensation limits the effect of user changes in fresh gas flow rate on the patient. The traditional bellows system is driven by oxygen and makes patient disconnections clearly visible.

### 1.3.7 Adjustable Alarms

Minimum and maximum alarm limits can be set for Peak Pressure, Mean Pressure and $FiO_2$. Minimum alarm limits can be set for Tidal Volume and Minute Volume. Exceeding the peak pressure alarm limit automatically halts the inspiratory phase preventing airway pressure from exceeding the high alarm setting. In the CMV mode, when reaching this pressure limit, a "High Airway Pressure" alarm is displayed, and inspiration is discontinued. The next inspiration occurs at the regular time interval, preventing increase of the respiratory rate. The result is a decreased tidal volume (T Vol.) and minute volume (M Vol.). During pressure limitation, the ventilator displays the alarm message until the condition is corrected.

### 1.3.8 Compliance Compensation

Compliance compensation automatically corrects for the expansion of the circuit in CMV ventilation mode. System compliance is measured by the ventilator to maintain the set tidal volume (±15%). The compliance test may be bypassed at machine power up. When bypassing the compliance test, the default settings are used.

# 1.4 Electrical Supply

## 1.4.1 Electrical components

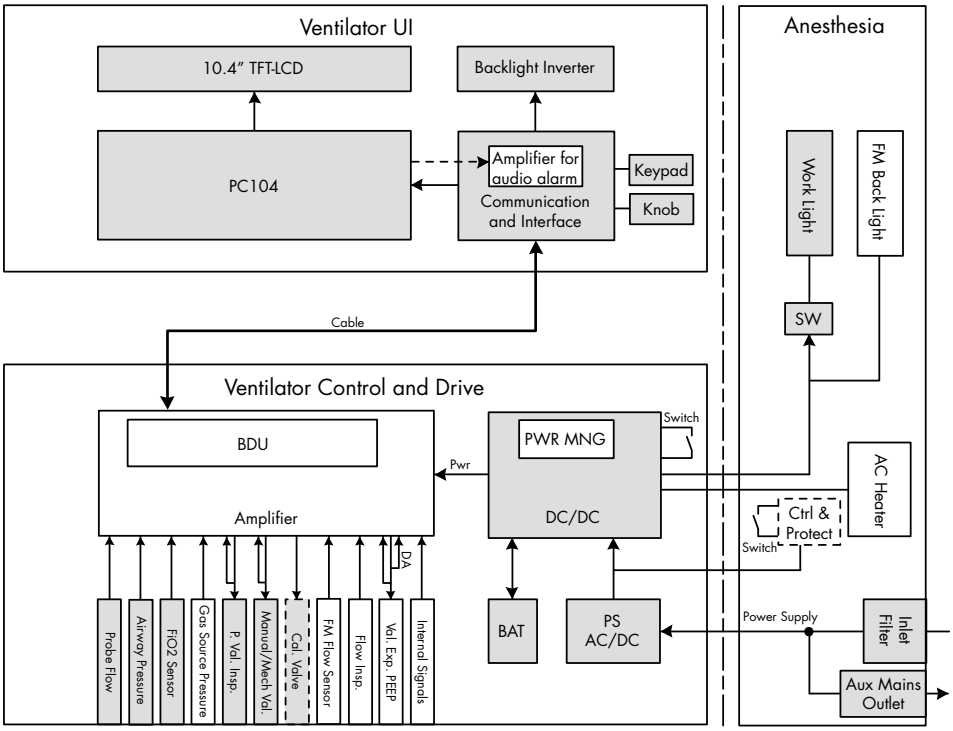


**FIGURE 1-5** Electrical Components Overview

# 1.5 Ventilator Control and Drive

## 1.5.1 BDU (Basic Digital Unit)

The BDU serves as the active ventilator control. The BDU controls the actions of the PEEP, calibration, and proportional valves, and reads the signal flow, and pressure sensors and valves

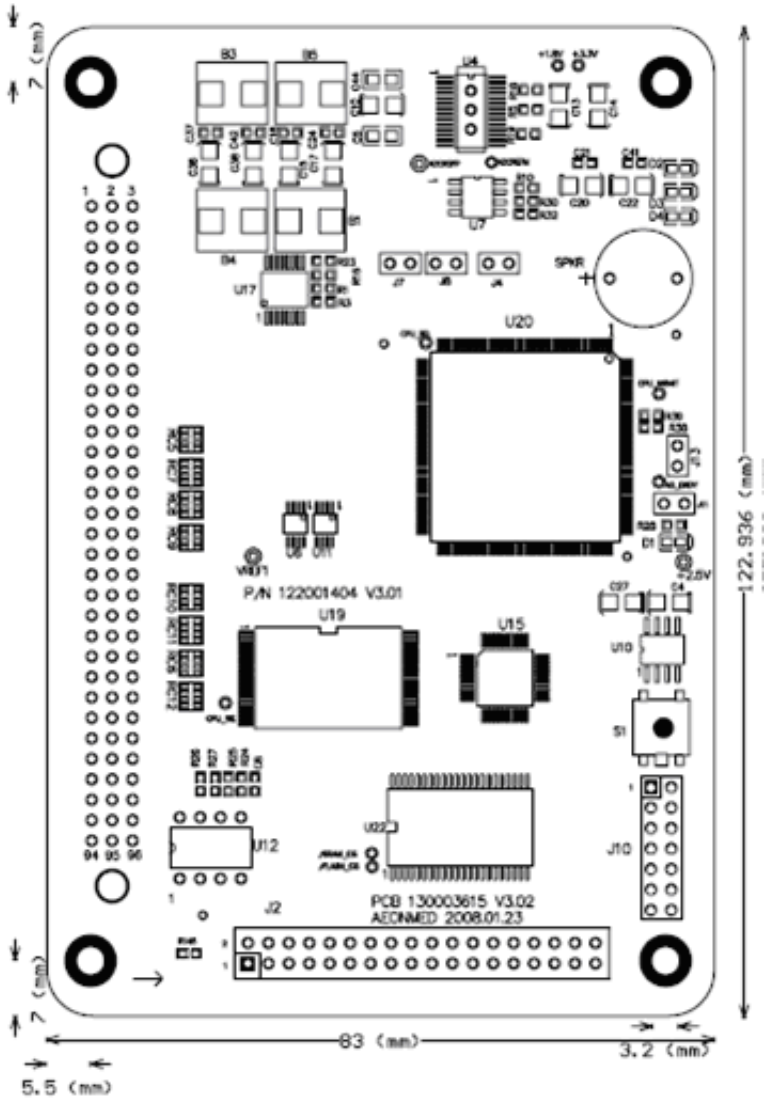


**FIGURE 1-6** BDU Control Board, Top View

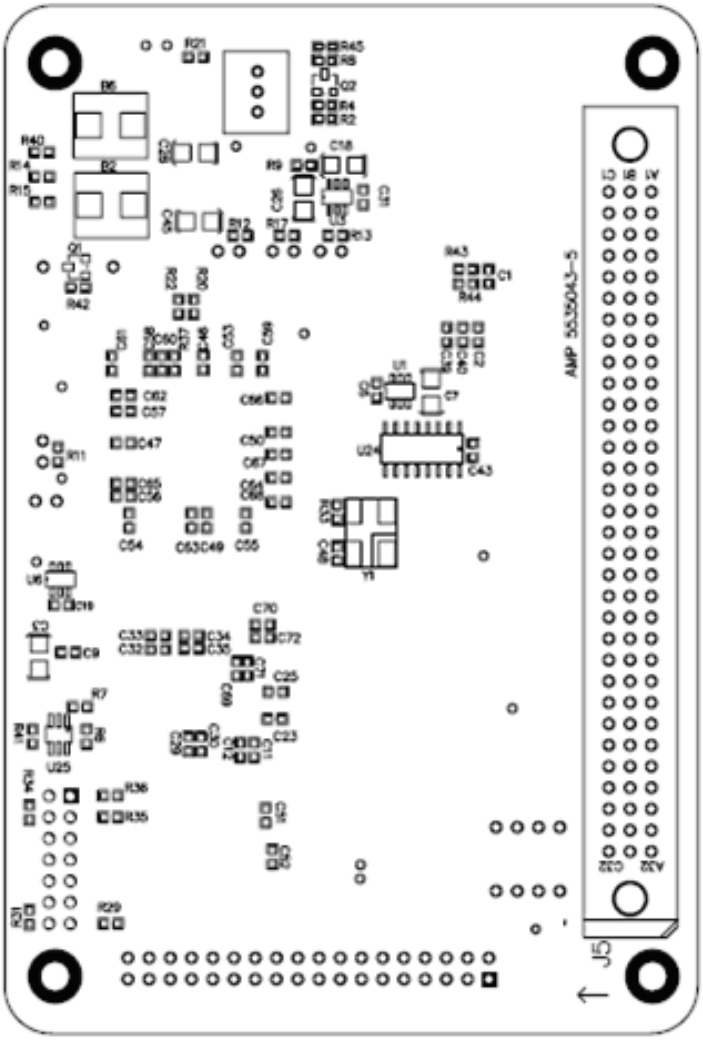


**FIGURE 1-7** BDU Control Board, Bottom View

### 1.5.1.1 Amplifier Board

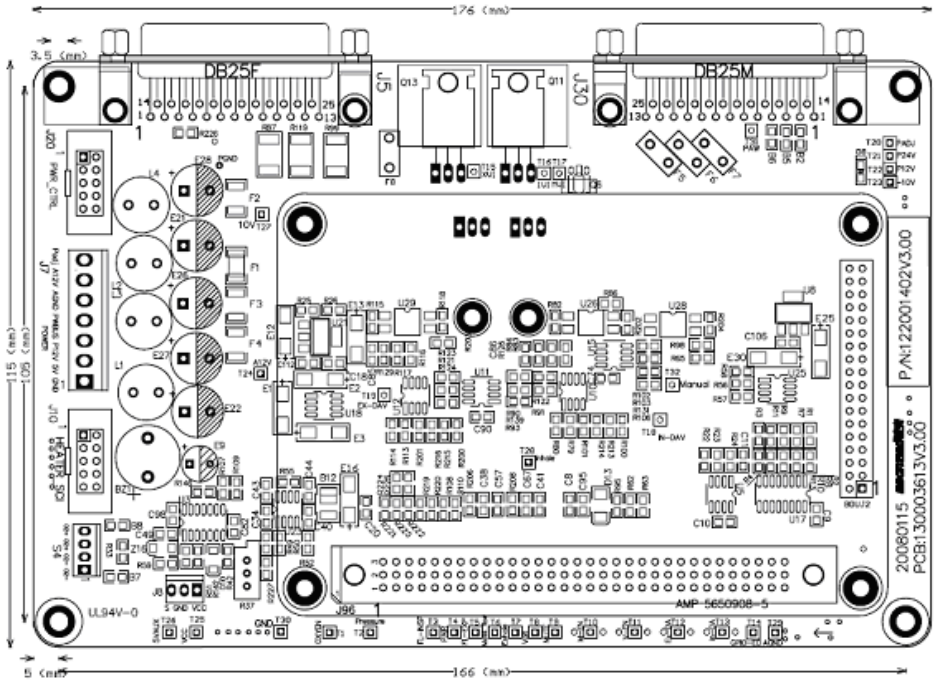


**FIGURE 1-8** Amplifier Board, Top View

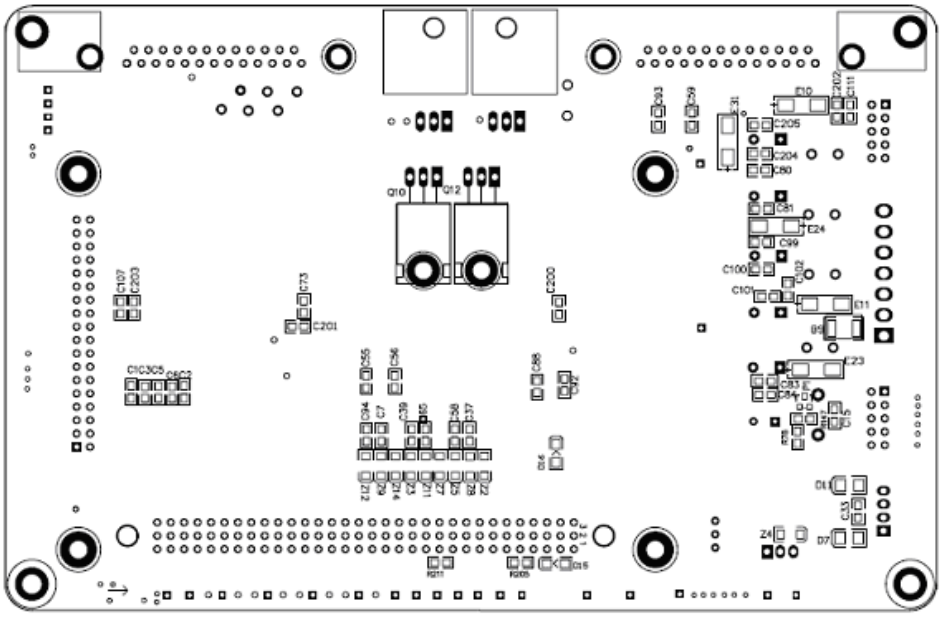

**FIGURE 1-9** Amplifier Board, Bottom View

## $O_2$ Sensor Input, S4

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | $O_2$- | $O_2$ Sensor Input - |
| 2. | $O_2$- | $O_2$ Sensor Input - |
| 3. | $O_2$+ | $O_2$ Sensor Input + |
| 4. | $O_2$+ | $O_2$ Sensor Input + |

## DC Power Input, J7

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Power Ground |
| 2. | +5V | Controller Logic Power |
| 3. | P12V | Power 12V |
| 4. | PWBUS | Power Bus 24V |
| 5. | GND | Analog Ground |
| 6. | A12V | Analog 12V |
| 7. | 5V/4.8V | Power 5V/4.8V |

## Power Control, J20

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Ground |
| 2. | /PWON | Power On Enable, Low active |
| 3. | PWEN | Power On Enable, High active |
| 4. | 5VAUX | 5V Auxiliary |
| 5. | DC_M | AC/DC Monitor signal |
| 6. | PWBUS | Power bus |
| 7. | BAT_M | Battery Monitor signal |
| 8. | APE | Auxiliary Power Enable |
| 9. | CHAR_SIGNAL | Charge Status, No connection |
| 10. | /MUTE | Mute, No connection |

## Signals and Power to Keyboard, J5

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | ENPW | Power Enable, High active |
| 2. | /PWON / | Power on Enable, Low active |
| 3. | 5VAUX | 5V Auxiliary |
| 4. | APE | Auxiliary Power Enable |
| 5. | GND | Ground |
| 6. | TTLRX | TTL Receive |
| 7. | 232ARX | RS232A Receive |
| 8. | 232BRX | RS232B Receive |
| 9. | GND | Ground |

## Signals and Power to Keyboard, J5 (Continued)

| PIN | NAME | FUNCTION |
|---|---|---|
| 10. | PWBUS | PowerBus |
| 11. | PWBUS | PowerBus |
| 12. | PWBUS | PowerBus |
| 13. | GND | Ground |
| 14. | GND | Ground |
| 15. | DC24V | DC24V monitor |
| 16. | BATV+ | Battery monitor |
| 17. | /MUTE | No connection |
| 18. | GND | Ground |
| 19. | TTLTX | TTL Transmit |
| 20. | 232ATX | RS232A Transmit |
| 21. | 232BTX | RS232B Transmit |
| 22. | GND | Ground |
| 23. | PWBUS | PowerBus |
| 24. | PWBUS | PowerBus |
| 25. | GND | Ground |

## Signals and Power to Sensor Board, J30

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | A+12V | Analogue +12V |
| 2. | FL_INS | Import flow |
| 3. | FL_EXP | Export flow |
| 4. | FM_FL | Flowmeter flow |
| 5. | Pair | Pressure of air |
| 6. | Paw | Pressure inside air way |
| 7. | Pgas | Pressure gas supply status |
| 8. | GND | Ground |
| 9. | AGND | Analog Ground |
| 10. | AGND | Analog Ground |
| 11. | P24V | Power 24V |
| 12. | P24V | Power 24V |
| 13. | P24V | Power 24V |
| 14. | P12V | Power 12V |
| 15. | P12V | Power 12 |
| 16. | P5V | Power 5V |
| 17. | P5V | Power 5V |
| 18. | Inhale | Inspire Valve |
| 19. | Man | Manual/AUTO Valve |
| 20. | Exhale | Expire Valve |
| 21. | Exhale | Expire Valve |
| 22. | AGND | Analog Ground |

## Signals and Power to Sensor Board, J30 (Continued)

| PIN | NAME | FUNCTION |
|---|---|---|
| 23. | AGND | Analog Ground |
| 24. | AGND | Analog Ground |
| 25. | AGND | Analog Ground |

## Bus to BDU, J96

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 - 3 | 5V | 5V Power |
| 4 - 6 | GND | Ground |

## Test Point Definition

| DESIGNATOR | NAME | FUNCTION | RANGE |
|---|---|---|---|
| T1 | $FIO_2$ | ADC input of $O_2$ Sensor | 0.25-0.51V (In AIR) |
| T2 | Pgas | Pressure switch of gas supply, low active | |
| T3 | FL_INSP | Inspire Flow signal | 0.20-0.30V (0 flow) |
| T4 | Pair | Absolute Pressure of air way | 1.7-2.1V (atmospheric pressure) |
| T5 | FL_EXP | Expire flow signal | 0.20-0.30V (0 flow) |
| T6 | Fm_fl | Flow of flowmeter | 0.25-0.51V (flowmeter off) |
| T7 | AD-Exhale | PEEP valve, current feedback | Level depends on PEEP setting and vent mode. No activity may indicate open connection from driver to valve (ie. bad cable) |
| T8 | Volt | Internal power inspect | |
| T9 | MUTE | Not used | |
| T10 | M-EN | Manual/Auto mode select | |
| T11 | V-EN | Valves enable Input | Global valve enable signal. Must be active for valves to operate. |
| T12 | EX-DA | Exhale DA output | |
| T13 | In-DA | Inhale DA output | |
| T14 | GS_ST | gas supply status, high active | |
| T15 | XVI | unamplified version of T7 | |
| T16 | IVI | unamplified version of T28 | |
| T17 | MVI | Manual-Valve current feedback | |
| T18 | IVG | Proportional valve drive signal, drives T16 and T28 | Level depends on machine settings. |
| T19 | XVG | PEEP valve drive signal - drives T15 and T7 | Level depends on PEEP setting and vend mode. |
| T20 | PADJ | Power 4.8V | 4.8V |
| T21 | P24V | Power 24V | 24V |
| T22 | P12V | Power 12V | 12V |

## Test Point Definition

| DESIGNATOR | NAME | FUNCTION | RANGE |
|---|---|---|---|
| T23 | -10V | Negative Voltage -10V | -10V |
| T24 | A12V | Analogue 12V | 12V |
| T25 | VCC | Power 5V | 5V |
| T26 | 5VAUX | 5V Auxiliary | 5V |
| T27 | 10V | Analogue +10V | +10V |
| T28 | AD-Inhale | Inhale-STATE feedback | No activity may indicate open connection from driver to valve (ie. bad cable) |
| T29 | AGND | Analogue Ground | |
| T30 | GND | Ground | |
| T31 | PAW | Pressure inside air way | 0.45-0.55 (open to atmosphere) |
| T32 | Manual | Manual/Auto Valve feedback | |

### 1.5.1.2 Drive Gas Pressure Sensor Board

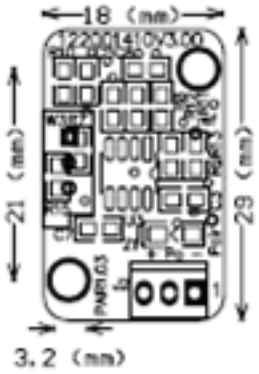


**FIGURE 1-10** Drive Gas Pressure Sensor Board, Top View

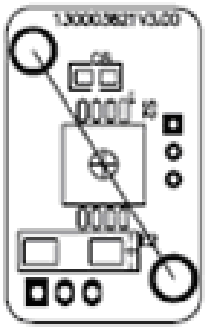

**FIGURE 1-11** Drive Gas Pressure Sensor Board, Bottom View

## Pair Board

## Pair, J1

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | AGND | Analog Ground |
| 2. | Pair | Pressure of air |
| 3. | NC | No connection |
| 4. | AR10V | 10V |
| 5. | NC | No connection |

### 1.5.1.3 PAW Pressure Sensor Board

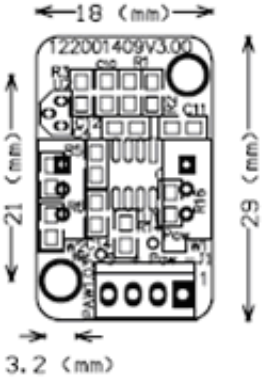


**FIGURE 1-12** Paw Pressure Sensor Board, Top View

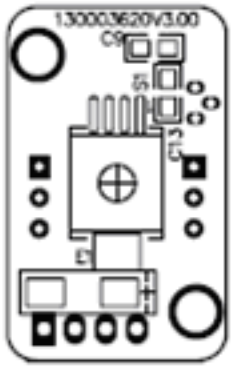


**FIGURE 1-13** Paw Pressure Sensor Board, Bottom View

## Paw Board

## Paw, J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | AGND | Analog Ground |
| 2. | Paw | Pressure inside airway |
| 3. | AR5V | 5V |
| 4. | NC | No connection |
| 5. | NC | No connection |

### 1.5.1.4 Breathing System Heater

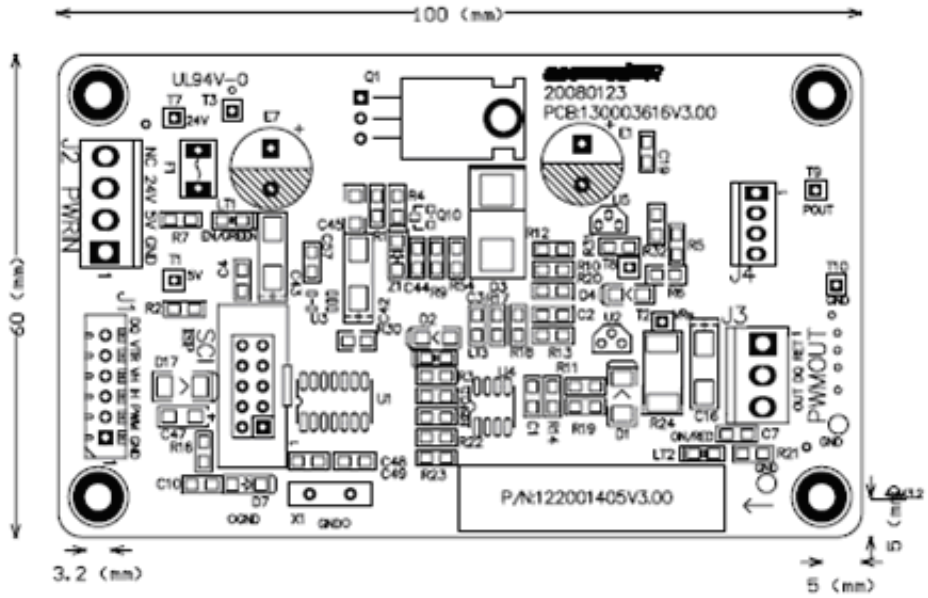


**FIGURE 1-14** Breathing System Heater Board, Top View

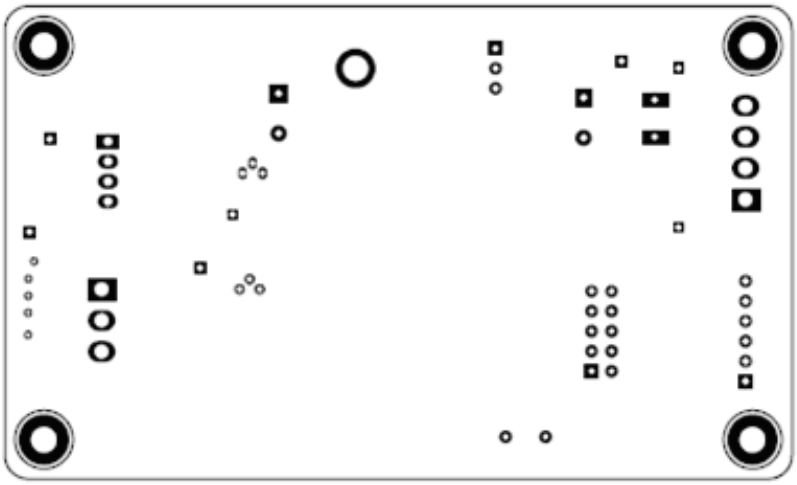

**FIGURE 1-15** Breathing System Heater Board, Bottom View

## J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 2. | GND | Power Ground |
| 3. | 5V | Controller Power, Output Enable |
| 4. | 24V | Heater Power Supply |
| 5. | NC | No Connection |

## J3

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | RET | Heater Power Ground |
| 2. | DQ | Sensor signal |
| 3. | 24V | Heater Output |

## Test point definition

| DESIGNATOR | NAME | FUNCTION |
|---|---|---|
| T10 | GND | Power Ground |
| T1 | 5V | Controller Power |
| T7 | 24V | Heater Power input |
| T9 | POUT | Heater Output |

## Indicating lamp definition

| DESIGNATOR | STATUS | FUNCTION |
|---|---|---|
| LT2 | RED | Heater Output available |
| LT3 | GREEN | Heater Ready |

### 1.5.1.5 Sensor Board

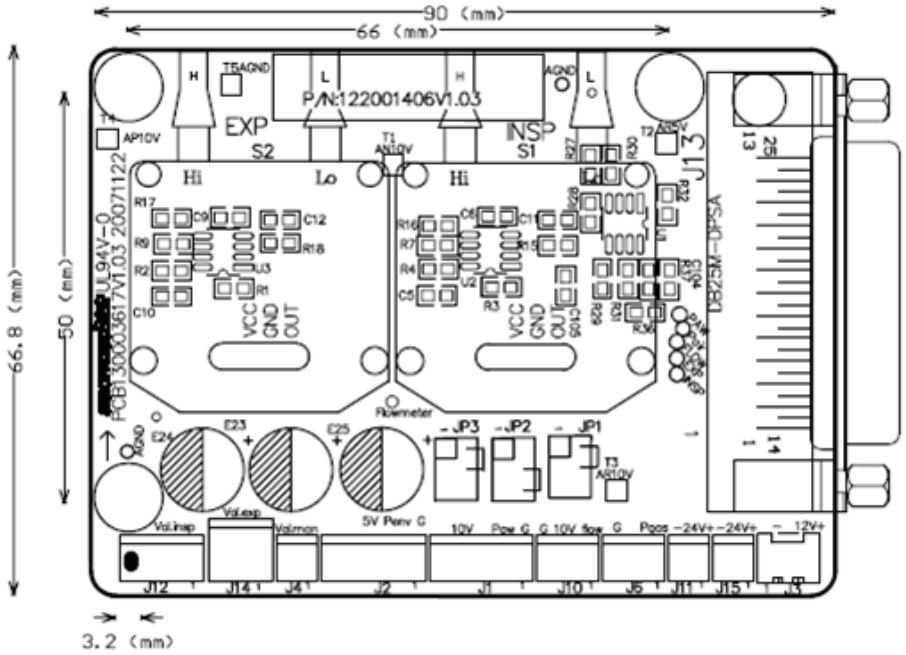


**FIGURE 1-16** Sensor Board, Top View

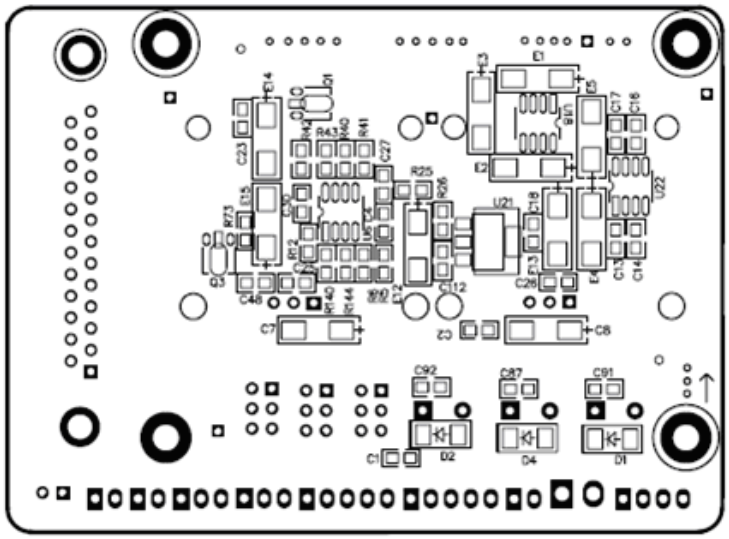

**FIGURE 1-17** Sensor Board, Bottom View

## Sensor Board Pair, J1

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | AGND | Analog Ground |
| 2. | Pair | Pressure of air |
| 3. | NC | No connection |
| 4. | AR10V | 10V |
| 5. | NC | No connection |

## PAW, J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | AGND | Analog Ground |
| 2. | Paw | Pressure inside airway |
| 3. | AR5V | 5V |
| 4. | NC | No connection |
| 5. | NC | No connection |

## Work Light Power, J11

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 24V | Power 24V |
| 2. | GND | Power Ground |

## Backlight Power, J15

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 24V | Power 24V |
| 2. | GND | Power Ground |

## Switch of Gas Supply, J6

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Ground |
| 2. | NC | No connection |
| 3. | Pgas | Switch input |

## Expire Valve, J14

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 5V | 5V |
| 2. | Valexp Expire | Valve Drive |

## Inspire Valve, J12

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 - 2 | 24V | 24V |
| 3 - 4 | Valexp inspire | Valve Drive |

## Man/Auto Valve, J14

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 24V | 24V |
| 2. | Valman | Manual/Auto Valve Drive |

## Signals and Power of Sensor Board, J13

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | A+12V | Analogue +12V |
| 2. | FL_INS | Import flow |
| 3. | FL_EXP | Export flow |
| 4. | FM_FL | Flowmeter flow |
| 5. | Pair | Pressure of air |
| 6. | Paw | Pressure inside air way |
| 7. | Pgas | Pressure gas supply status |
| 8. | GND | Ground |
| 9. | AGND | Analog Ground |
| 10. | AGND | Analog Ground |
| 11. | P24V | Power 24V |
| 12. | P24V | Power 24V |
| 13. | P24V | Power 24V |
| 14. | P12V | Power 12V |
| 15. | P12V | Power 12 |
| 16. | P5V | Power 5V |
| 17. | P5V | Power 5V |
| 18. | Inhale | Inspire Valve |
| 19. | Man | MANUAL/AUTO Valve |
| 20. | Exhale | Expire Valve |
| 21. | Exhale | Expire Valve |
| 22. | AGND | Analog Ground |
| 23. | AGND | Analog Ground |
| 24. | AGND | Analog Ground |
| 25. | AGND | Analog Ground |

## 1.5.2 Power Management

Power management is located behind the Rear Panel Assembly. This module serves as the voltage supply for the ventilator control and drive BDU, the flowmeter backlight, the work light, the Breathing System Heater, and the charging/discharging control for the battery.

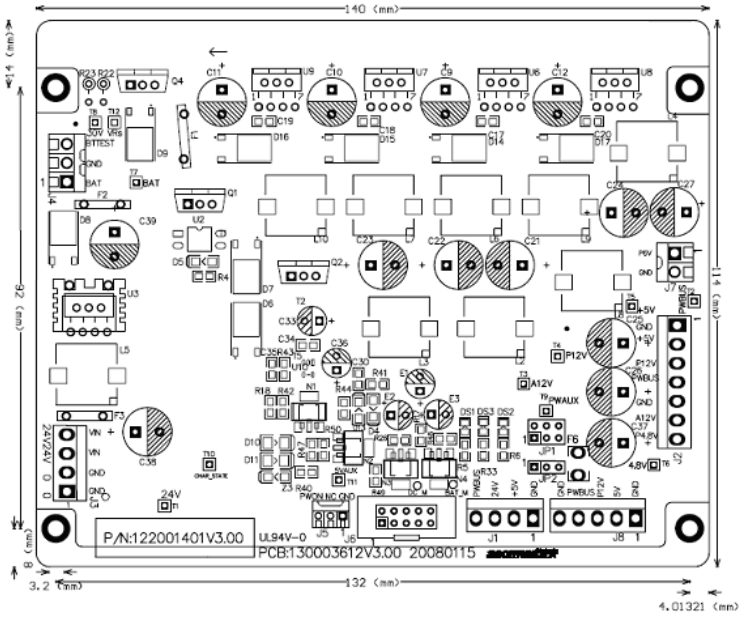


**FIGURE 1-18** Power Board, Top View

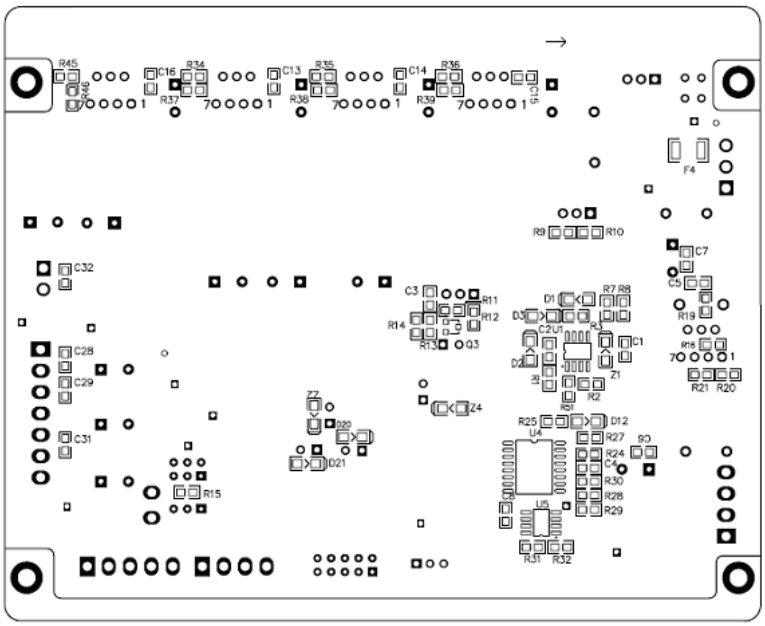

**FIGURE 1-19** Power Board, Bottom View

# Power Board

## Battery input, J4

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | BAT | Battery Input + |
| 2. | 5V | Power Ground |
| 3. | BATTEST | Battery test input |

## DC24V Power input, J3

| PIN | NAME | FUNCTION |
|---|---|---|
| 4. | GND | Power Ground |
| 5. | GND | Power Ground |
| 6. | 24V | Power input |
| 7. | 24V | Power input |

## DC Power output, J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Power Ground |
| 2. | +5V | Controller Logic Power |
| 3. | P12V | Power 12V |
| 4. | PWBUS | Power Bus 24V |
| 5. | GND | Analog Ground |
| 6. | A12V | Analog 12V |
| 7. | 5V/4.8V | Power 5V/4.8V |

## Heater Power, J1

| PIN | NAME | FUNCTION |
|---|---|---|
| 6. | GND | Power Ground |
| 7. | 5V | Controller Power, Output Enable |
| 8. | 24V | Heater Power Supply |
| 9. | PBUS | Power Bus, No Connection |

## Power Control, J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Ground |
| 2. | /PWON | Power On Enable, Low active |
| 3. | PWEN | Power On Enable, High active |
| 4. | 5VAUX | 5V Auxiliary |
| 5. | DC_M | AC/DC Monitor signal |
| 6. | PWBUS | Power bus |
| 7. | BAT_M | Battery Monitor signal |

### Power Control, J2 (Continued)

| PIN | NAME | FUNCTION |
|---|---|---|
| 8. | APE | Auxiliary Power Enable |
| 9. | CHAR_SIGNAL | Charge Status, No connection |
| 10. | /MUTE | Mute, No connection |

### Power Switch, J5

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | GND | Ground |
| 2. | NC | No Connection |
| 3. | PWON | Power On Enable, Low active |

### Test Point definitions

| DESIGNATOR | NAME | FUNCTION |
|---|---|---|
| T1 | 24V | 24V DC Input |
| T2 | PWBUS | Power Bus |
| T3 | A12V | Analogue 12V |
| T4 | P12V | Power 12V |
| T5 | +5V | Logic Power 5V |
| T6 | 5V/4.8V | Power 5V/4.8V |
| T7 | BAT+ | Battery Input + |
| T8 | 30V | 30V for charger |
| T9 | PWAUX | Power Auxiliary |
| T10 | CHARGE | Charge Status |
| T11 | 5VAUX | 5V Auxiliary |
| T12 | VRs | Charger Feedback |

### Led Designation

| DESIGNATOR | LED COLOR | STATUS FUNCTION |
|---|---|---|
| DS1 | GREEN | 24V DC available |
| DS2 | GREEN | Power Bus On |
| DS3 | GREEN | Charge |

## 1.5.3 Battery

The sealed lead-acid battery is maintenance free, and has a maximum recharge time of 8 hours when fully discharged. The run time is at least 45 minutes with a fully charged battery. To prevent unintended loss of battery operation, the recommended replacement period is every 3 years.

## 1.5.4 Power Supply

The power supply provides power to the machine and relevant controls.

# 1.6 Anesthesia System Components

## 1.6.1 Auxiliary Outlets

The **AS3000** has four auxiliary outlets (120 VAC, 60 Hz, 2A maximum each). There are two 2A fuses for each outlet.

## 1.6.2 Absorber Heater Wire Board

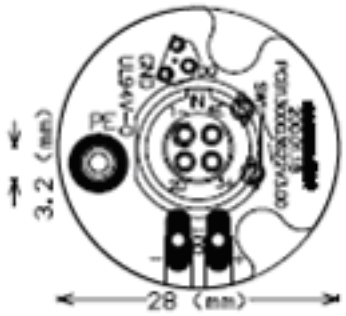


**FIGURE 1-20** Absorber Heater Wire Board, Top View

**FIGURE 1-21** Absorber Heater Wire Board, Bottom View

## 1.6.3 Work Light Board

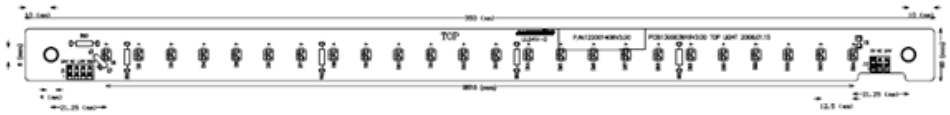


**FIGURE 1-22** Work Light Board, Top View

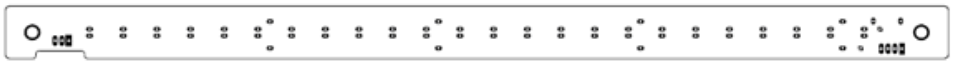

**FIGURE 1-23** Work Light Board, Bottom View

## Work light Power, J11

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 24V | Power |
| 2. | NC | No Connection |
| 3. | GND | Power Ground |

## Work light switch, J11

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 24V | Power 24V |
| 2. | NC | No Connection |
| 3. | LOW | Low dim |
| 4. | HIGH | High dim |

# 1.7 Ventilator UI

## 1.7.1 Keyboard Board

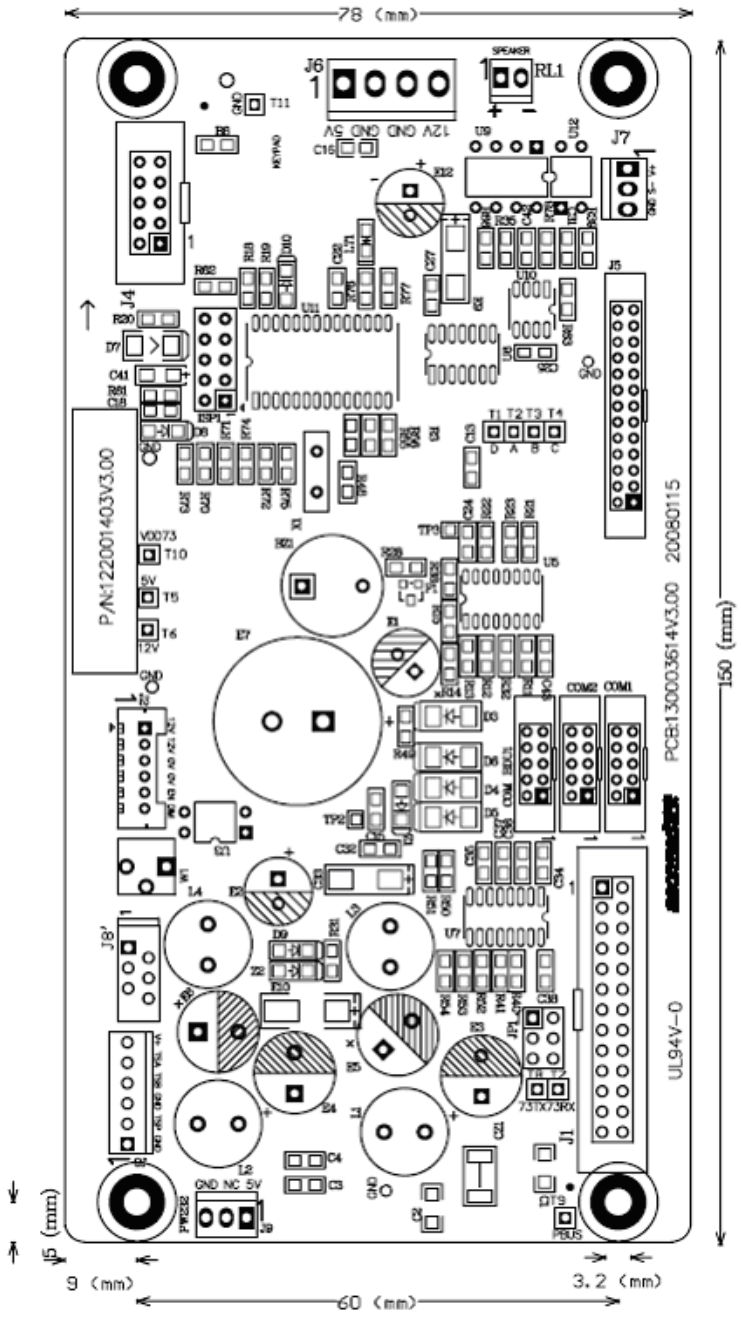


**FIGURE 1-24** Keyboard Board, Top View

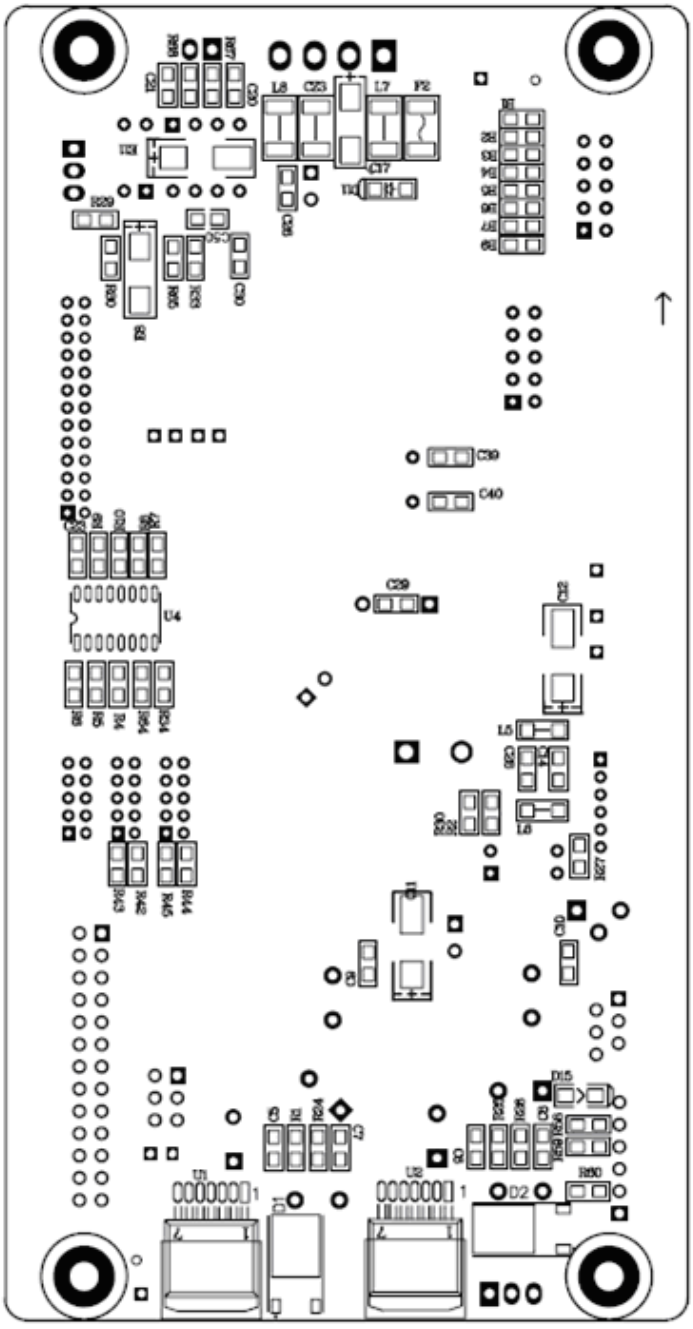


**FIGURE 1-25** Keyboard Board, Bottom View

# Keyboard

## Signals and Power of Keyboard, J1

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | ENPW | Power Enable, High active |
| 2. | GND | Ground |
| 3. | /PWON / | Power on Enable, Low active |
| 4. | DC24V | DC24V monitor |
| 5. | 5VAUX | 5V Auxiliary |
| 6. | BATV+ | Battery monitor |
| 7. | APE | Auxiliary Power Enable |
| 8. | /MUTE | No connection |
| 9. | GND | Ground |
| 10. | GND | Ground |
| 11. | TTLRX | TTL Receive |
| 12. | TTLTX | TTL Transmit |
| 13. | 232ARX | RS232A Receive |
| 14. | 232ATX | RS232A Transmit |
| 15. | 232BRX | RS232B Receive |
| 16. | 232BTX | RS232B Transmit |
| 17. | GND | Ground |
| 18. | GND | Ground |
| 19. | PWBUS | PowerBus |
| 20. | PWBUS | PowerBus |
| 21. | PWBUS | PowerBus |
| 22. | PWBUS | PowerBus |
| 23. | PWBUS | PowerBus |
| 24. | GND | Ground |
| 25. | GND | Ground |

## PC104 Power output, J6

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 5V | Controller Logic Power |
| 2. | GND | Power Ground |
| 3. | GND | Power Ground |
| 4. | 12V Power | 12V, No connection |

## Backlight Power, J2

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 12V | Power output |
| 2. | 12V | Power output |
| 3. | GND | Power Ground |
| 4. | GND | Power Ground |

### Backlight Power, J2 (Continued)

| PIN | NAME | FUNCTION |
|---|---|---|
| 5. | ON/OFF | Backlight ENABLE |
| 6. | DIM | Contrast adjust |

### Power of 232 Isolator, J9

| PIN | NAME | FUNCTION |
|---|---|---|
| 1. | 5V | Power 5V |
| 2. | NC | No connection |
| 3. | GND | Ground |

### COM1/2

| PIN | NAME | FUNCTION |
|---|---|---|
| 2 | RXD | 232RXD TO PC104 INPUT |
| 3 | TXD | 232TXD TO PC104 OUTPUT |
| 5 | GND | Ground |

### Test Point Definition

| DESIGNATOR | NAME | FUNCTION |
|---|---|---|
| T5 | +5V | Logic Power 5V |
| T6 | P12V | Power 12V |
| T9 | PWBUS | Power Bus |

### LED Designation

| DESIGNATOR | STATUS | FUNCTION |
|---|---|---|
| LT1 | GREEN/BLINK | Keyboard ready |

## 1.7.2 Display

The display is a 10.4 inch TFT LCD

## 1.7.3 Communication Interface / RS232 Isolate Board

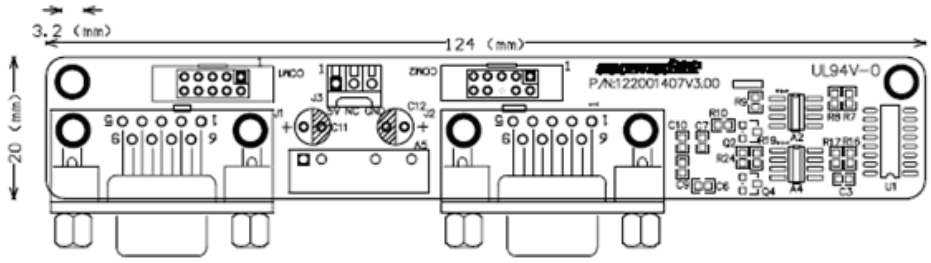


**FIGURE 1-26** RS232 Isolate Board, Top View

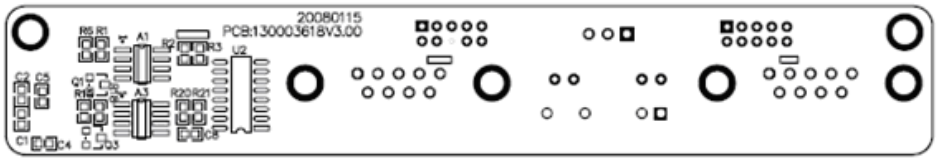


**FIGURE 1-27** RS232 Isolate Board, Bottom View

### RS232 Isolator

### Power, J3

| Pin | Name | Function |
|---|---|---|
| 4. | 5V | Power 5V |
| 5. | NC | No connection |
| 6. | GND | Ground |

### COM1/2

| Pin | Name | Function |
|---|---|---|
| 2 | RXD | 232RXD TO PC INPUT |
| 3 | TXD | 232TXD TO PC OUTPUT |
| 5 | GND | Ground |

### COM1A/B

| Pin | Name | Function |
|---|---|---|
| 2 | TXD | 232TXD TO PC OUTPUT |
| 3 | RXD | 232RXD TO PC INPUT |
| 5 | GND | Ground |

## 1.7.4 Fuses

The **AS3000** has 10 fuses on the back panel of the unit. There are two 2A fuses for each of the four outlets and two 10A fuses for the line cord.

# 1.8 Ventilator Pneumatic - $O_2$ Drive Gas

## 1.8.1 Ventilator pneumatic drive

Oxygen is the driving gas for the ventilator. In addition to the flowmeter block, a high pressure regulator reduces the supply pressure to 25.4 psi (175 kPa). This pressure represents the drive gas for the ventilator.

The drive pressure regulator is placed ahead of the proportional valve that generates the driving gas flow during the inspiratory phase. This flow fills the bellows dome that surrounds the bellows.

## 1.8.2 Drive Pressure-High pressure regulator

The drive pressure regulator stabilizes the supply pressure provided to the proportional valve. The flow generated by the proportional valve is therefore independent of pressure variations at the supply.

Setting the drive pressure regulator at 25.4 psi (175 kPa) allows for a maximum inspiratory flow of 70 L/min at the ventilator.

## 1.8.3 Gas Box Assembly

The driving module consists of the proportional valve and a solenoid valve for the vent mode switch. The proportional valve pressure regulator, and generates a driving gas flow of 0 - 70 L/min in relation to the control voltage of the proportional valve of 0 - 5VDC.

The control voltage of the proportional valve, required for the pre-selected parameter settings, is generated by the BDU board. The driving gas flow $Q_{drive\ gas}$ is in the following relationship with the tidal volume:

$Q_{drive\ gas} = V_T/T$

with: $Q_{drive\ gas}$ = driving gas flow

$V_T$ = generated tidal volume

T = time

## 1.8.4 Tube color coding

All the pneumatic tubes used in the **AS3000** are color coded for use in the United States only.

| GAS | US STANDARD |
|---|---|
| $O_2$ | Green |
| $N_2O$ | Blue |
| AIR | Yellow |

# 1.9 The Breathing System

## 1.9.1 CMV mode, inspiration

Tidal volume (T Vol.) compensates for variations in gas flow. This is to ensure that the set tidal volume is delivered to the patient.

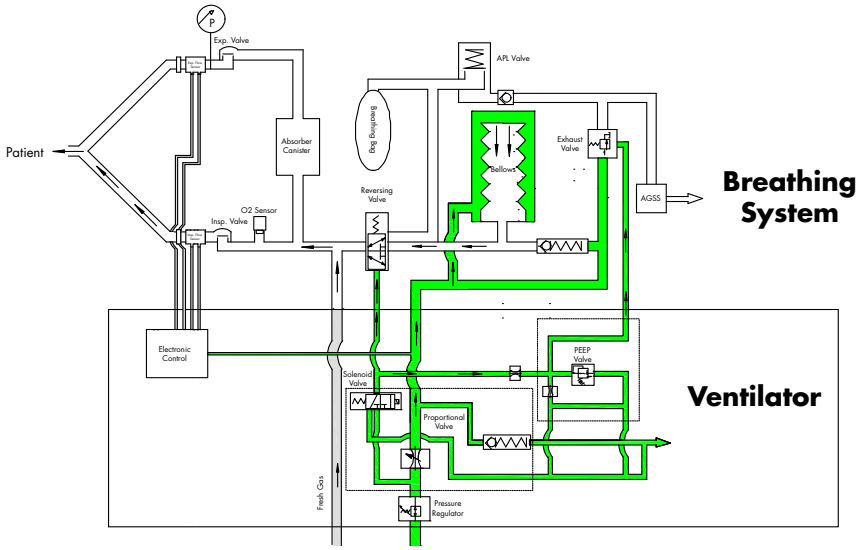


**FIGURE 1-28** Breathing System Pneumatics, CMV Mode, Inspiration

## 1.9.2 CMV mode, expiration

As the patient exhales tidal volume into the expiratory limb, fresh gas enters the bellows. Fresh gas mixes with exhaled gas after the Absorber removes $CO_2$. Excess fresh gas passes through the exhaust valve to the AGSS

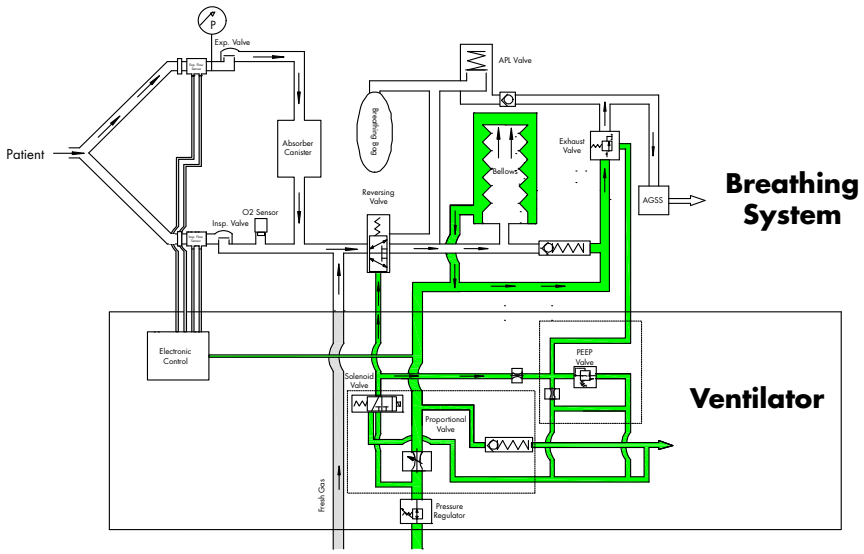


**FIGURE 1-29** Breathing System Pneumatics, CMV Mode, Expiration

## 1.9.3 Manual mode, inspiration

As the breathing bag is compressed, the gas is directed to the patient. Pressures exceeding the set value of the APL Valve will pass through the APL Valve the AGSS.

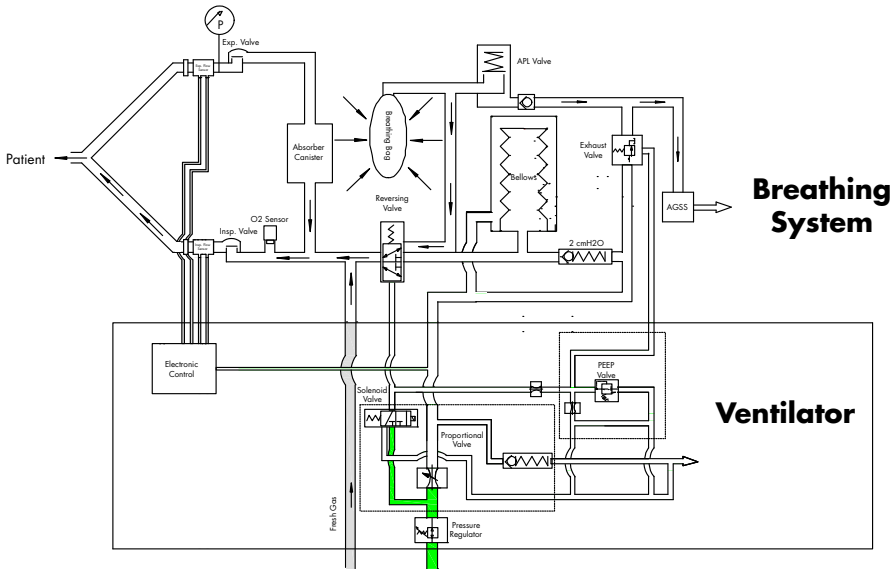


**FIGURE 1-30** Breathing System Pneumatics, Manual Mode, Inspiration

## 1.9.4 Manual mode, expiration

As the patient exhales tidal volume into the expiratory limb, fresh gas enters the Breathing System. Fresh gas mixes with exhaled gas after the Absorber removes $CO_2$. Excess fresh gas passes through the exhaust valve to the AGSS

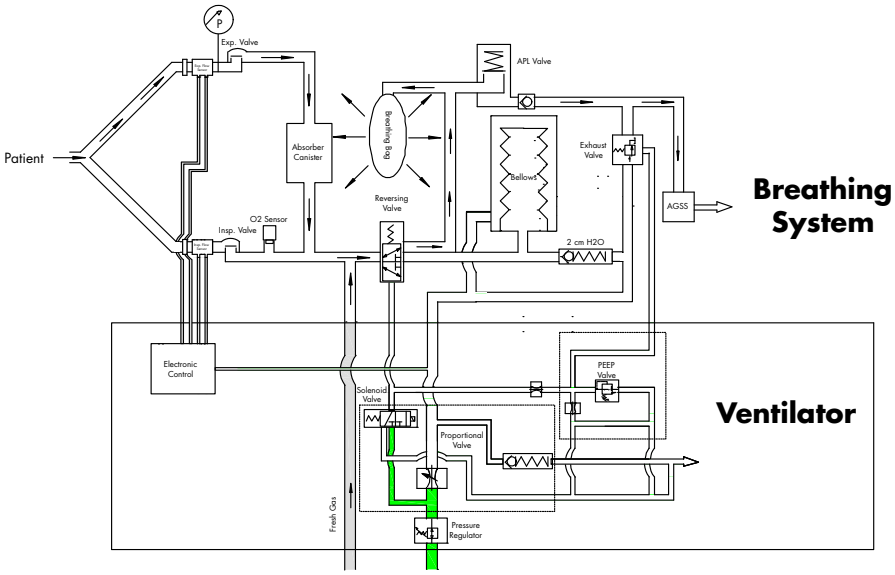


**FIGURE 1-31** Breathing System Pneumatics, Manual Mode, Expiration

### 1.9.5 Pneumatic PEEP

The PEEP valve regulates the pressure at which the exhaust valve opens, therefore the exhaust valve opens only when the pressure exceeds the set PEEP pressure.

### 1.9.6 Ventilator in Standby

When the **AS3000** is in the standby mode, monitoring will be inactive, The patient should not be ventilated when the system is in standby mode.

### 1.9.7 Breathing System Components

#### 1.9.7.1 Ventilation Bellows System

The ventilator's driving system is a flow generator. Driving gas fills the bellows dome to compress the bellows. The breathing gas is pressed out of the bellows into the patient breathing circuit. The bellows is refilled with fresh gas and the expired gas from the patient.

#### 1.9.7.2 Manual Breathing Bag

In manual mode, this device acts as a normal breathing bag, enabling the user to ventilate the patient manually. In mechanical ventilation mode, this bag is cut off from the breathing circuit by the reversing valve.

#### 1.9.7.3 $CO_2$ Absorber

The soda lime inside the absorber retains the carbon dioxide from the exhaled gas. The **AS3000** accommodates standard sized Pre-Paks or loose-fill $CO_2$ absorbent.

#### 1.9.7.4 Inspiratory and Expiratory Valves

To ensure correct gas flow direction to and from the patient, one-way-valves are integrated in the inspiratory and expiratory limb of the Breathing System.

#### 1.9.7.5 APL (Airway Pressure Limiting) valve

In manual mode, the APL Valve acts as a normal spring loaded pressure relief valve, limiting the maximum pressure in the Breathing System.

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# 2.0 *Installation Guide*

## 2.1 Delivery of The New Anesthesia Machine

The following customer supplied material must be present prior to installation. Missing equipment can result in delays, incomplete installations and/or extra visits.

- Compatible emergency $O_2$, $N_2O$, and AIR cylinders
- Agent vaporizers and key fillers, if not purchased with the **AS3000**
- Liquid agent medication
- $CO_2$ absorbent Pre-Paks or loose fill
- Active $O_2$, $N_2O$, and AIR, lines at 50 psi
- Drop down hoses for ceiling mounted medical gas utilities, compatible with quick-disconnect hoses if not purchased with the **AS3000**
- Activated medical gases ($O_2$, $N_2O$, AIR, VAC, and EVAC)

# 2.2 Assembly

**NOTE: The AS3000 Breathing System Block is matched to the AS3000 it is attached to by calibration and installation. After removing the Breathing System Block from the Mounting Arm of the AS3000, assure that the Breathing System Block is returned to the same AS3000 that it came from originally.**

## 2.2.1 Unpacking

1. Inspect the two boxes for any damage, check the tip watches, and report any damage or sign of tipping to the dispatcher.
2. Ensure the serial numbers on both carton labels match prior to assembling the system.
3. Remove the shipping straps and caps from the 2 boxes.
4. Remove the foam from inside the top of the box.
5. Remove the Corrugated box from around **AS3000**.
6. Remove the bag and shrink wrap from around **AS3000**.
7. Remove the foam from **AS3000** casters.

## 2.2.2 Breathing System and Breathing System Accessories

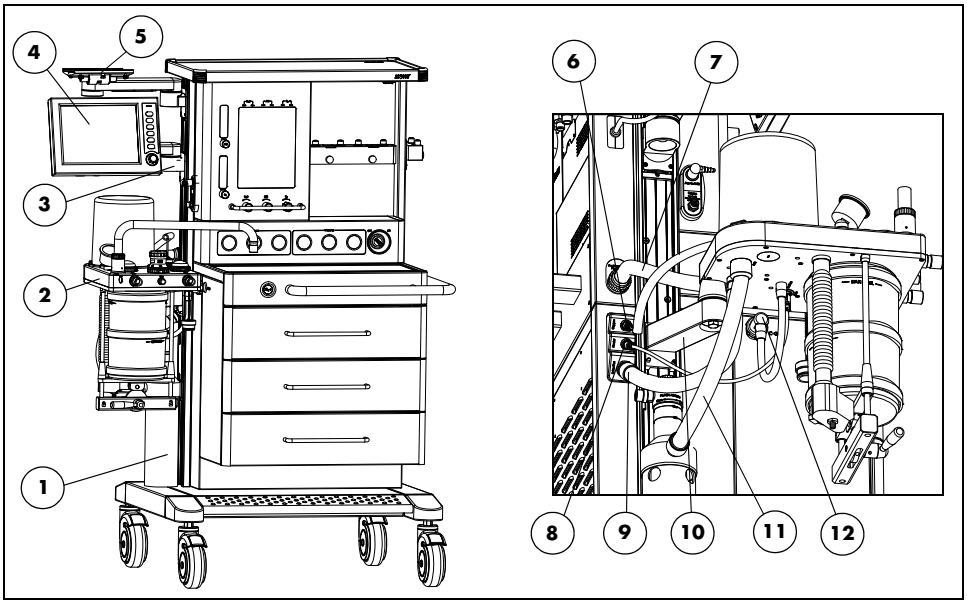


**FIGURE 2-1** The **AS3000** and accessories

1. **AGSS**
2. **Breathing System**
3. **User Interface Mounting Arm**
4. **User Interface**
5. **Patient Monitor Mounting Arm**
6. **$O_2$ Cable**
7. **Pneumatic Hose Assembly**
8. **Heater Cable**
9. **Drive Gas**
10. **Breathing System Mounting Arm**
11. **AGSS Transfer Hose**
12. **CGO Port**

### 2.2.2.1 Attaching the Mounting Arms and User Interface

(see FIGURE 2-1)

1. Remove the mounting arms from small box and install them onto the **AS3000** using a 3 mm allen wrench.
2. Remove the keys from the parts box, and unlock the **AS3000** drawers and put parts box into top drawer.
3. Remove the AGSS and Breathing System mount from the foam packaging, and install them onto the **AS3000**.
4. Remove the User Interface and slide it onto the User Interface mounting arm.
5. Apply Loctite 243 to the User Interface cable jackscrews and jackposts. Then, connect the User Interface cable to the User Interface. Ensure the jackscrews are securely tightened.

### 2.2.2.2 Breathing System Connections

(see FIGURE 2-1)

1. Remove the foam and bag from around the Breathing System.
2. Ensure that the serial number tag attached to the bag arm matches the serial number found on the package carton.
3. Install the Breathing System onto the arm on the left side of the **AS3000** by attaching it to the installed bracket.
4. Attach the Drive Gas Hose to the bottom port of the Breathing System
5. Attach the Heater cable into the port located on the bottom of the Breathing System
6. Install the $O_2$ Cell to the $O_2$ Interface
7. Attach the $O_2$ cell to the $O_2$ cable and insert the cell into its designated port on the Breathing System.
8. Attach the Pneumatic Hose Assembly to the designated port on the rear of the Breathing System.
9. Attach the AGSS Transfer Hose to its designated port on the bottom of the Breathing System.

### 2.2.2.3 Anesthesia System Connections

(see FIGURE 2-1)

1. Attach the Fresh Gas Hose of the Breathing System to the CGO port on the system.

2. Attach the Drive Gas Hose to the designated port on the Breathing System Interface.
3. Attach the Heater Cable to the designated port on the Breathing System Interface.
4. Attach the $O_2$ Cable to the designated port on the Breathing System Interface.
5. Attach the Pneumatic Hose Assembly to the designated connector labeled **Breathing System Pneumatics**.
6. Attach the AGSS Transfer Hose.

### 2.2.3 Tank Wrench and Pre-operation Checklist

1. Mount the tank wrench on the rear of the **AS3000** so that it can be used to open or close each cylinder, without disconnecting it from the machine.
2. Attach the pre-operation checklist to a location on the **AS3000** where the operator can access it.

### 2.2.4 Patient Suction Regulator and Arm

1. Remove the Patient Suction Regulator and mounting arm from its packaging.
2. Attach the mounting arm to the customers desired channel. It mounts to either side channel.
3. Tighten the locking screw.
4. Thread the patient suction regulator into its mating port on the mounting arm.
5. Attach a barbed fitting adapter to the suction regulator's VAC fitting as necessary to attach a hospital grade suction hose from the regulator output to the suction canister.

### 2.2.5 Suction Canister Bracket

1. Remove the suction canister bracket from its packaging.
2. Attach the bracket to the right lower rail and secure.

### 2.2.6 Utility Tray, Monitor Mounting Arm with Utility Hook(s)

1. Remove the items from their packing material.
2. Slide the utility tray into the desired channel.
3. Tighten the locking screw.
4. Remove the plastic cap from under the mounting arm's swivel head.
5. Mount the utility hook(s) under the swivel head of the arm using the screws and tool provided with the hook.
6. Slide the mounting arm into the desired channel. Allow enough room for mounting monitors at the desired height.
7. Tighten the locking screw.

### 2.2.7 Vaporizers

1. Prior to mounting, set the vaporizer to the **T** position. (Does not apply for all vaporizers.)

2. Discard the washers that came with the vaporizer. Use only approved O-rings that come mounted on the vaporizer mounting ports of the **AS3000**.
3. Mount a mechanical vaporizer to either side of the **AS3000** vaporizer mount by placing the vaporizer on the ports and locking down the lever.
4. Mount an electronic vaporizer in the same manner. Follow any installation instructions that come with the specific vaporizer.

### 2.2.8 High Pressure Hoses

1. Remove the hoses from their packing material.
2. Attach each hose to its mating connector by hand. Do not use any tools.
3. Use extreme care while attaching the EVAC hose to the waste gas scavenger (WGS); as it is extremely delicate.
4. Attach an EVAC hose to a VAC source connection only if an EVAC source connection is not available.

### 2.2.9 Emergency Cylinder(s)

1. Remove the cover from a new $O_2$, $N_2O$, and AIR cylinder.
2. Mount one at a time onto the rear of the anesthesia machine.
3. Discard the cylinder's tank washer. Always use the approved tank washer provided with the **AS3000**.
4. Open the bail of each yoke and mount the cylinder over the tank washer.
5. Ensure the $O_2$ cylinder mates to the $O_2$ Pin Index Safety System (PISS) connection on the $O_2$ yoke. Close the yoke bail and use the hand-screw to tighten the cylinder to the yoke port.
6. Open and close the cylinder valve and observe that the cylinder gauge on the anesthesia machine rises to the colored range.
7. Ensure that the $N_2O$ cylinder mates to the $N_2O$ PISS connection on the $N_2O$ yoke. Close the yoke bail and use the hand-screw to tighten the cylinder to the yoke port.
8. Open and close the cylinder valve and observe that the cylinder gauge on the anesthesia machine rises to the colored range.
9. Ensure that the AIR cylinder mates to the AIR PISS connection on the AIR yoke. Close the yoke bail and use the hand-screw to tighten the cylinder to the yoke port.
10. Open and close the cylinder valve and observe the cylinder gauge on the anesthesia machine rise to the colored range.

### 2.2.10 Breathing Circuit, $CO_2$ Absorbent, and Liquid Vaporizer Agent

1. Attach a breathing circuit to the inspiratory and expiratory ports as detailed in the directions for use. Attach the breathing bag and any other respiratory accessories as described.
2. Insert the Pre-Paks one on top of the other with the wider side facing up on both Pre-Paks. (alternatively the absorber canisters may be filled with loose fill absorbent.)
3. Install the absorber canister with a quarter turn of the lever at the bottom the absorber assembly, this ensures a tight seal.

## 2.2.11 Monitoring Products - Mounting and Electrical Connection

1. Any monitoring system compatible with the GCX mounting system's swivel head may be mounted to the **AS3000**'s arm.

**NOTE: Use of other monitors and mounting hardware is the responsibility of the installer.**

2. Always make full use of all mounting fasteners and strap capturing devices when mounting monitors to the **AS3000**.
3. After mounting a monitor to the **AS3000**, connect it to one of the AC outlets located on the rear of the **AS3000**.
   a. Turn on each monitor one at a time and ensure that the circuit breaker holds without tripping.
   b. Dress each line cord neatly along the side of the anesthesia machine so that it can not be easily pulled or extend far from the main chassis.

## 2.2.12 Agent Monitor Waste Gas Scavenging

1. Respiratory gas monitoring products have an exhaust port from which waste gas expels. The exhaust port on the gas monitor must be connected to the open barbed fitting on the waste gas scavenger.
2. Ensure that a tight connecting fitting is attached to the rear of the gas monitor. Ensure that the other end of the same tube has a tight fitting connection attached to the waste gas scavenger's (WGS) barbed fitting.
3. Dress the exhaust tubing neatly along the side of the anesthesia machine so that it can not be easily pulled or extend far from the main chassis.

## 2.2.13 Oxygen Sensor Calibration

**NOTE: See "Periodic Maintenance Schedule of Service Activities" on page 6-2 for when to calibrate the oxygen sensor.**

1. **Preparing the unit**
   a. Allow the breathing system to warm up and reach thermal equilibrium (approximately 30-60 minutes).
   b. In Standby mode, press the **MENU** button. The menu screen will appear.
   c. Select **Service**, then input the password **2010** to enter the Service screen.
   d. Select **Calibration** to enter the Calibration screen.
   e. Select **Oxygen Sensor** to enter the Oxygen Sensor Calibration screen.
2. **Calibration**

**NOTE: Do not shake the $O_2$ sensor during calibration.**

**NOTE: During calibration, keep the $O_2$ sensor in a vertical position, connector side up, and bottom side exposed to room air; keep the $O_2$ sensor near the heated block to minimize the temperature difference from within the heated block.**

**NOTE:** **If the system is going to be used during the calibration, insert the $O_2$ cell plug into the port from which the oxygen sensor was removed using a push and turn motion.**

**a.** Select **21%** to enter the 21% oxygen concentration calibration screen.

**b.** Remove the oxygen sensor from the Breathing System and expose it to room air for at least 3 minutes.

**c.** Flush the $O_2$ sensor with air from the auxiliary output for 5-10 seconds to ensure that no $O_2$ bubbles are trapped in the sensor.

**d.** Select **Next** to start 21% oxygen concentration calibration.

**NOTE:** **The $O_2$ sensor voltage is displayed during the calibration. This is the amplified $O_2$ cell voltage at the A/D converter for the oxygen sensor. The $O_2$ sensor voltage is not displayed for UI versions 2.24 and lower.**

**e.** When calibration is successfully completed, install the oxygen sensor into the Breathing System.

**NOTE:** **The oxygen sensor must be installed in the Breathing System for 10 minutes prior to 100% oxygen concentration calibration to adjust to the temperature of the system.**

**f.** Press the $O_2$ Flush button for 5-10 seconds to clear out any non-$O_2$ gases from the system.

**g.** Expose the oxygen sensor to 100% pure oxygen (5 L/min) for at least 3 minutes.

**h.** Select **100%** to enter the 100% oxygen concentration calibration screen.

**i.** Select **Next** to start 100% oxygen concentration calibration.

# 2.3 Installation Checkout Procedure

Complete each step to verify the functionality of the **AS3000** prior to clinical use.

Also, perform this checkout after installation, reinstallation, servicing or after any periodic maintenance activity. This checklist does not replace periodic maintenance actions that must be performed to maintain peak performance.

1. **Verify that all components are present, and inspect for physical damage.**
   - **a.** Ensure that the Operating Instructions is present.
   - **b.** Verify unit is free from cosmetic defects. Plastics, labeling and display window are free from inclusions, pitting, bulges, sink marks, nicks, scratches, gouges dents, discolorations, etc. Verify all major hardware is fastened properly.
   - **c.** Verify that there are Tank Washers for each of the external cylinder yokes.
   - **d.** Verify that each vaporizer's locking spring is intact on the manifold by looking through the opening and checking for the visible wire spring.
   - **e.** Verify that each connector of the vaporizer mount has an O-ring.
   - **f.** Verify that breathing circuit consumables and $CO_2$ absorbent are present.
   - **g.** Inspect the $O_2$, $N_2O$, AIR, VAC, and EVAC supply hoses for damages.
   - **h.** Turn the flow control knobs for $O_2$, AIR and $N_2O$ and verify that the floats rise and spin as the flow is increased and fall freely as the flow is decreased.
   - **i.** inspect the AC line cord for fraying and damages.

2. **Verify that the laminated Preoperative Checkout card is attached.**

3. **Verify that the tank wrench is attached.**

4. **Verify that the waste scavenger flow rate is set and that the hose is intact, connected and dry.**
   - **a.** Attach the waste gas hose from the waste gas port on the Breathing System to one of the waste gas ports on the AGSS.
   - **b.** Attach the EVAC hose from the waste gas assembly DISS (Diameter Index Safety System) fitting to a source of vacuum.
   - **c.** Adjust the position of the float to be between the Min and Max lines by turning its flow adjustment knob (counterclockwise increases flow, clockwise decreases flow).

**5. Check $N_2O$, $O_2$ and AIR Lines for leaks.**

**a.** Remove the cylinders from the **AS3000**.

**b.** Connect the $O_2$, AIR and $N_2O$ hoses to the gas line inlets.

**NOTE: If a specific gas source is not available, skip the corresponding leak test.**

**c.** Verify $O_2$, AIR and $N_2O$ Line Pressure gauges read the corresponding line pressure.

**d.** Set the AIR flow controller to minimum.

**e.** Pinch to occlude the $O_2$, AIR and $N_2O$ hoses.

**f.** Disconnect each hose from its line pressure source.

**g.** Verify that the pressures do not drop more than 2 psi over a time period of 20 seconds.

**6. Verify that all available line and cylinder gauges are operational.**

**a.** Connect the $O_2$ supply hose and remove the AIR and $N_2O$ hoses.

**b.** Verify the $O_2$ Line Pressure gauge shows the reading of the line pressure.

**c.** Connect the AIR supply hose and remove the $O_2$ and $N_2O$ hoses.

**d.** Verify that the AIR Line Pressure gauges show the reading of the line pressure.

**e.** Connect the $O_2$ and $N_2O$ hoses and remove the AIR hose.

**f.** Verify that the $N_2O$ and $O_2$ Line Pressure gauge shows the reading of the line pressure.

**g.** Attach the cylinders to the **AS3000**'s yokes ($O_2$ and $N_2O$ or AIR). In the case where multiple cylinders of the same gas are required, attach one at a time.

**h.** Open all attached cylinders including the $O_2$ cylinder. If a cylinders pressure is less than 500 psi, replace the respective cylinder.

**i.** Verify that the cylinder pressure gauges register a pressure for each type of gas attached.

**7. Test $O_2$ Flush operation with only $O_2$ connected.**

**a.** Connect the $O_2$ supply hose and remove the AIR and $N_2O$ hoses.

**b.** Attach a calibrated flow meter to the Common Gas Outlet.

**c.** Push the $O_2$ Flush button and verify a reading between 35 L/min and 50 L/min at the flow meter.

**NOTE: $O_2$ flow may be greater than 50 L/min at higher altitudes.**

**d.** Reconnect the $O_2$, AIR and $N_2O$ hoses.

**8. Test the $O_2$:$N_2O$ ratio system (applicable to -01 units only).**

**a.** Set all flow control knobs to minimum.

**b.** Increase the flow of $N_2O$ until the $O_2$ reaches 1 L/min

**c.** Verify that the $N_2O$ flow is not higher than 3.7 L/min.

**d.** Return flow control knobs to minimum.

**9. Test the $O_2$:$N_2O$ ratio system (applicable to -02 units only).**

**a.** Set all flow control knobs to minimum.

**b.** Set the flow of $O_2$ to 1 L/min.

**c.** Open the $N_2O$ flow knob and verify that the $N_2O$ flow will not increase higher than 3.7 L/min.

**d.** Return flow control knobs to minimum.

**10. Perform System Test.**

**a.** Power ON the **AS3000**.

**b.** Wait until the System Self Test is complete

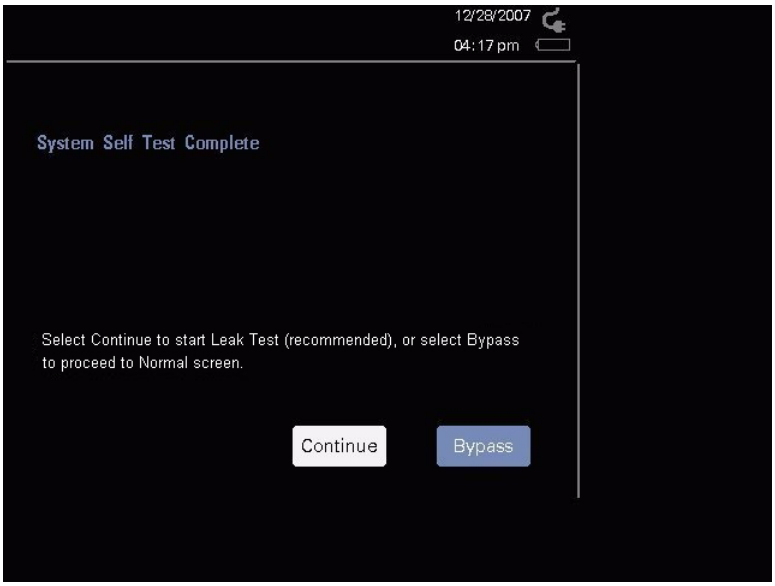


**FIGURE 2-2** Startup Self Test

**c.** Select **Continue** to prompt to the Safety Valve test

### 11. Perform Leak/Safety Valve Test

**a.** Follow the on-screen instructions.

**FIGURE 2-3** Leak Test Setup

**b.** Select **Continue** to start the test.

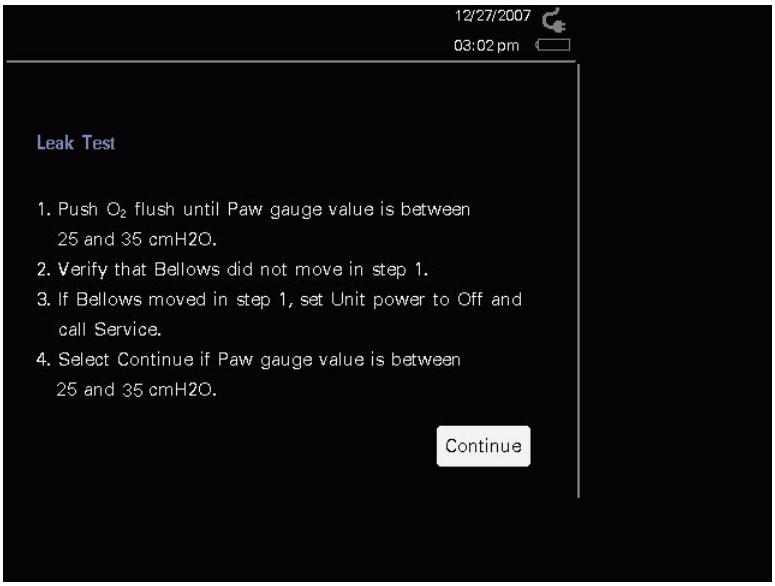


**FIGURE 2-4** Safety Valve Test Setup

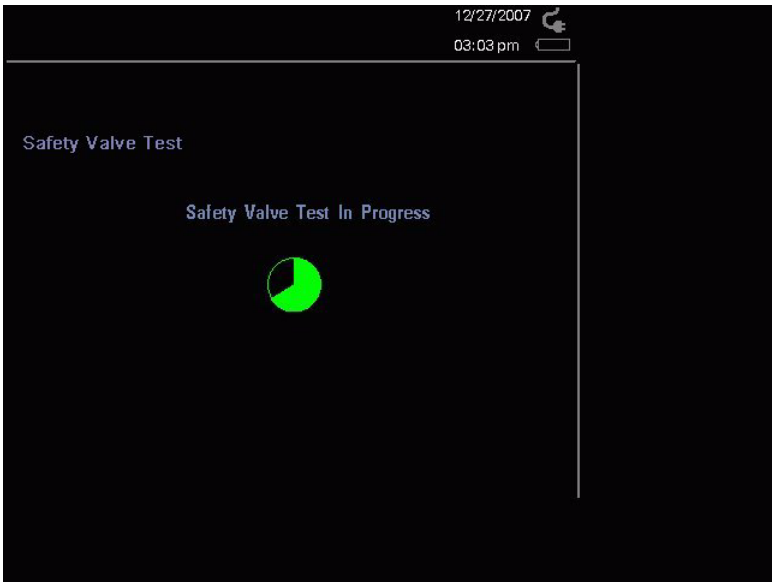


**FIGURE 2-5** Safety Valve Test in Progress

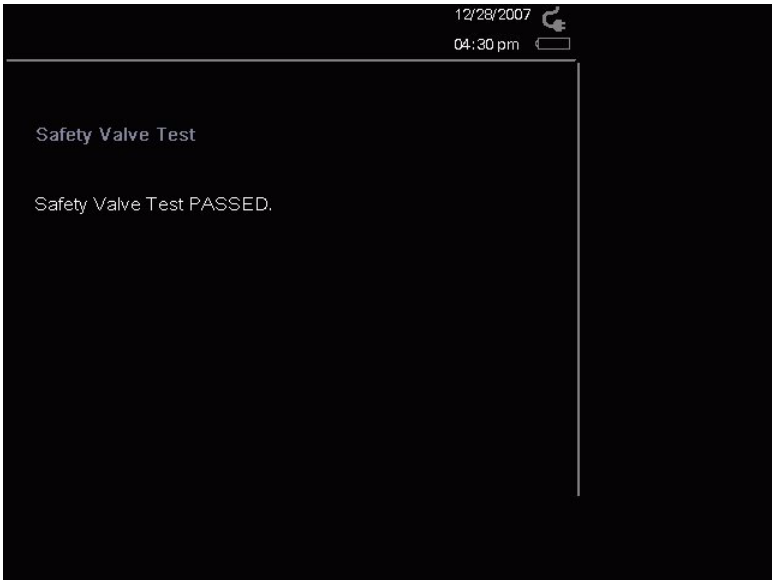


**FIGURE 2-6** Safety Valve Test Passed Message

**c.** After 3 seconds, the screen will prompt to the Leak Test.

### 12. Perform Leak Test

**a.** Follow the on-screen instructions.

**b.** Select **Continue** to start the test.

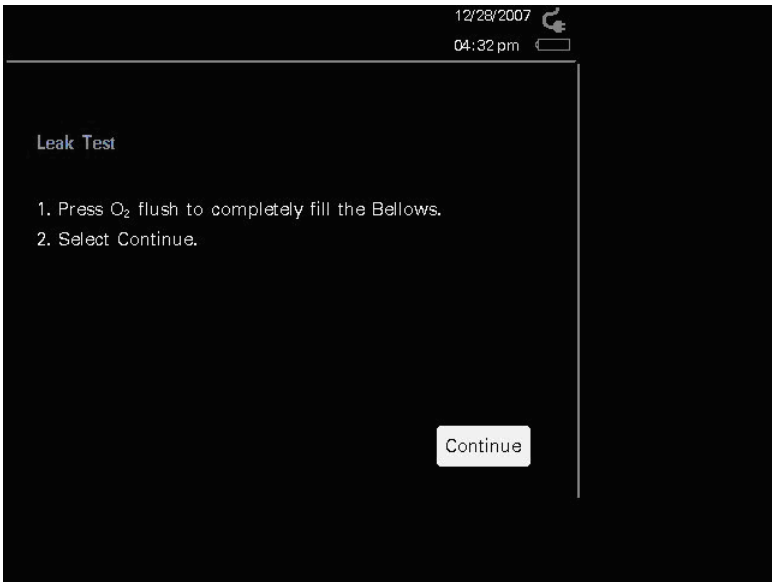


**FIGURE 2-7** Leak Test Setup

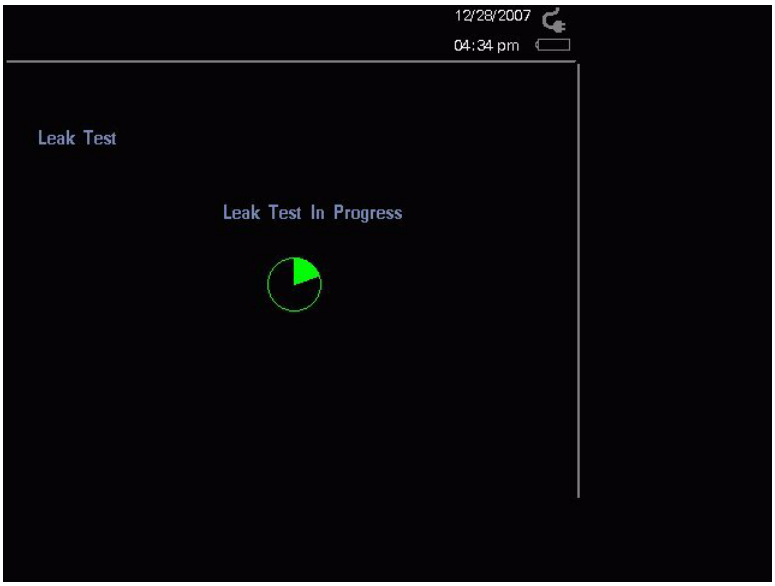


**FIGURE 2-8** Leak Test in Progress

**c.** Select **Continue** to prompt to the Compliance Test.

**FIGURE 2-9** Leak Test Results

**13. Perform Compliance Valve Test**

**a.** Follow the on-screen instructions.

**b.** Select **Continue** to start the test.

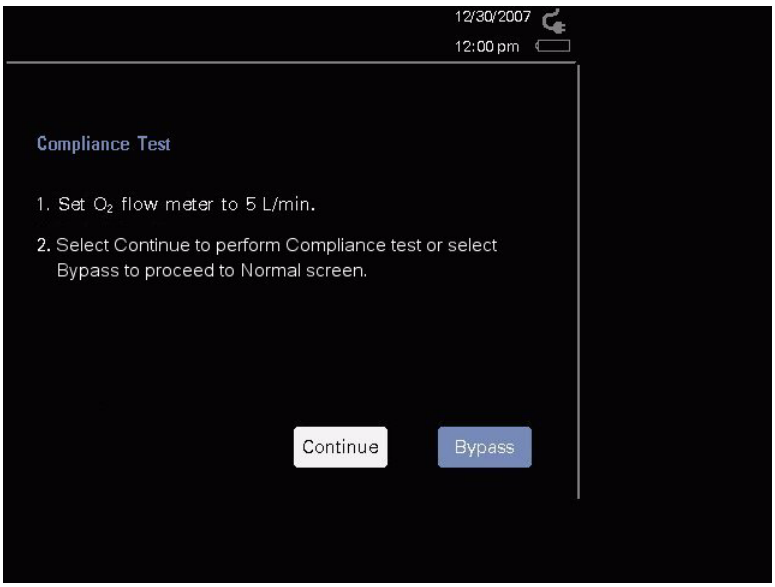


**FIGURE 2-10** Compliance Test Setup

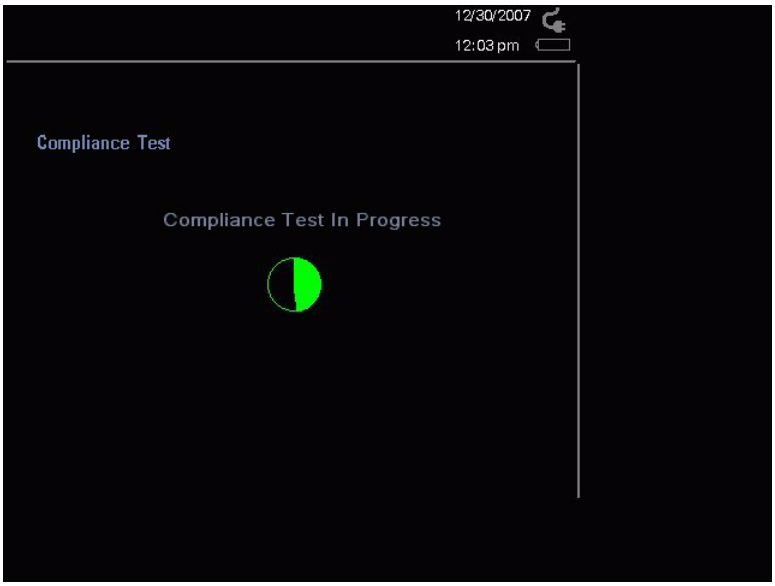


**FIGURE 2-11** Compliance Test in Progress

**c.** Select **Continue** to prompt to the Normal Screen.

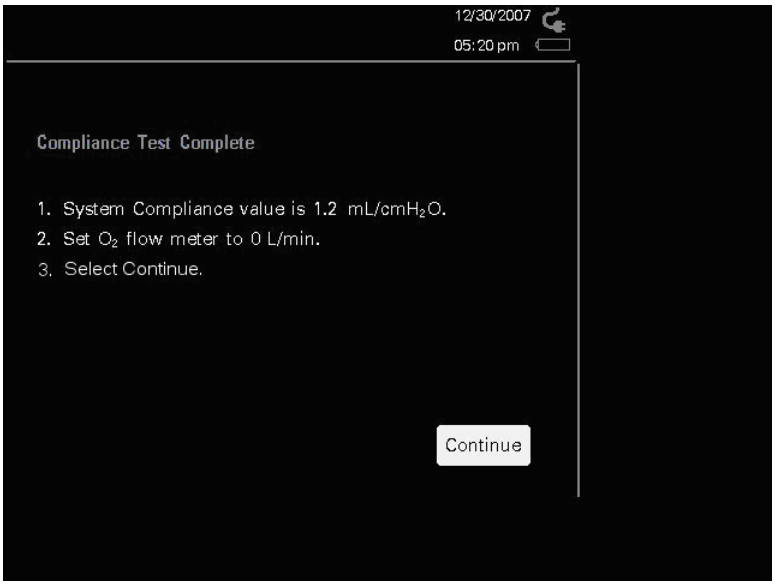


**FIGURE 2-12** Compliance Test Results

### 14. Manual Leak Test

**NOTE: The Manual Leak Test detects smaller leaks than can be detected in the Automatic Leak Test.**

**a.** Ensure that the gas pressure for $O_2$, $N_2O$, and AIR are at 50 ±10 psi.

**b.** Power ON the **AS3000**.

**c.** Attach a reusable-silicone-rubber breathing circuit to the Breathing System.

**NOTE: For testing purposes always use a reusable breathing circuit.**

**d.** Tightly connect the Y-fitting on the breathing circuit to the test port.

**e.** Attach a breathing bag to the bag arm.

**f.** Set the APL Valve to the fully closed position (**70** $cmH_2O$).

**g.** Rotate the $O_2$ Flow Control Valve until 50 $cmH_2O$ pressure is observed on the Airway Pressure Gauge.

**h.** Verify that the flow required to stabilize the pressure is less than 300 mL/min.

### 15. Oxygen Sensor Calibration

**NOTE: Oxygen Sensor Calibration can be performed in all ventilation modes.**

**NOTE: See "Periodic Maintenance Schedule of Service Activities" on page 6-2 for when to calibrate the oxygen sensor.**

**a.** Allow the breathing system to warm up and reach thermal equilibrium (approximately 30-60 minutes).

**b.** Press the **MENU** key and then use the **Navigator™ Knob** to scroll to the **Calibrate** menu tab (see FIGURE 2-13). Select the **Start Calibration** button.

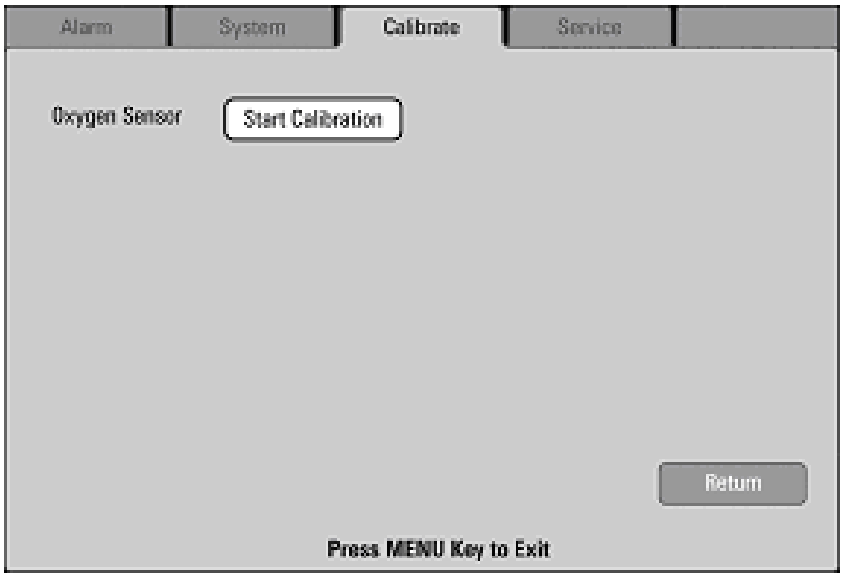


**FIGURE 2-13 Calibrate** Menu Tab

**c.** After the **Start Calibration** button has been selected, the screen shown in FIGURE 2-14 or FIGURE 2-16will be displayed, instructing the user to remove the oxygen sensor from the Breathing System and expose it to room air for at least 3 minutes before proceeding. The $O_2$ sensor voltage is displayed during the calibration. This is the amplified $O_2$ cell voltage at the A/D converter for the oxygen sensor.

**NOTE: The $O_2$ sensor voltage is not displayed for UI versions 2.24 and lower.**

**d.** Flush the $O_2$ sensor with air from the auxiliary output for 5-10 seconds to ensure that no $O_2$ bubbles are trapped in the sensor.

**NOTE: Do not shake the $O_2$ sensor during calibration.**

**NOTE: Keep the $O_2$ sensor in a vertical position, connector side up, during calibration.**

**NOTE: Place the $O_2$ sensor on top of the heated block during calibration to minimize the temperature difference from within the heated block.**

**NOTE:** **If the system is going to be used during the calibration, insert the $O_2$ cell plug into the port from which the oxygen sensor was removed using a push and turn motion.**

**e.** After at least 3 minutes have passed, select the **Next** button to initiate the calibration process. The progress bar shown in FIGURE 2-15 or FIGURE 2-17will be displayed.

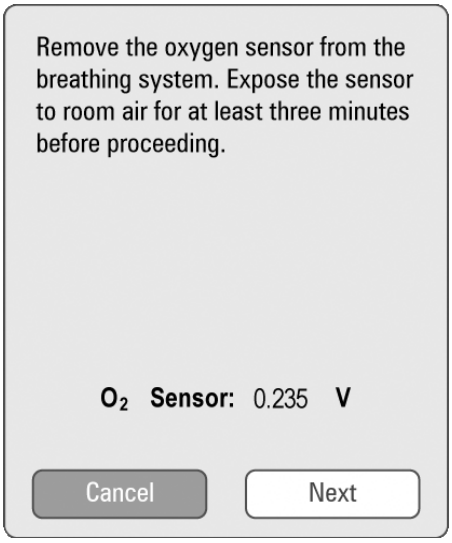


**FIGURE 2-14** Oxygen Sensor Calibration Instructions

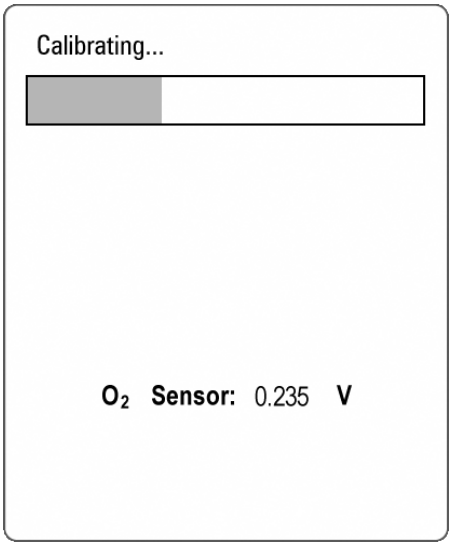


**FIGURE 2-15** Oxygen Sensor Calibration Progress Bar

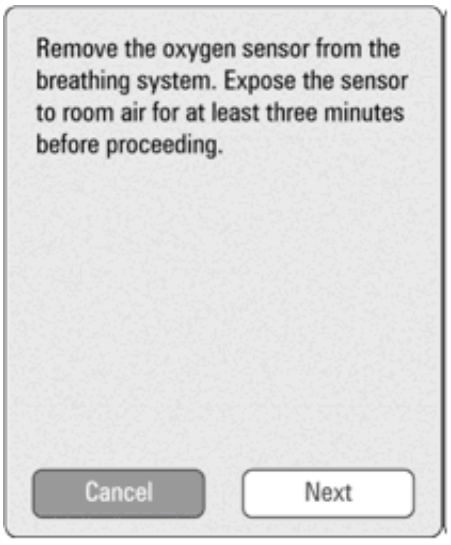


**FIGURE 2-16** Oxygen Sensor Calibration Instructions (UI versions 2.24 and lower)

**FIGURE 2-17** Oxygen Sensor Calibration Progress Bar (UI versions 2.24 and lower)

**16. Proceed based on one of the following two conditions:**

- **If the calibration is successful**, the screen shown in FIGURE 2-18 will be displayed, instructing the user to reinstall the oxygen sensor into the Breathing System. Select the **Done** button to complete the process.
- **If the calibration fails**, the screen shown in FIGURE 2-19 will be displayed, instructing the user to either repeat the calibration (by selecting the **Repeat Cal** button) or to replace the oxygen sensor. If the oxygen sensor must be replaced, select the **Exit** button, replace the oxygen sensor using a push and turn motion, and then repeat the calibration.

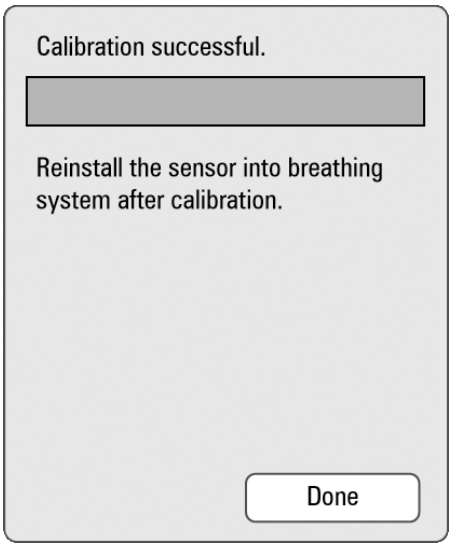


**FIGURE 2-18** Oxygen Sensor Calibration Successful

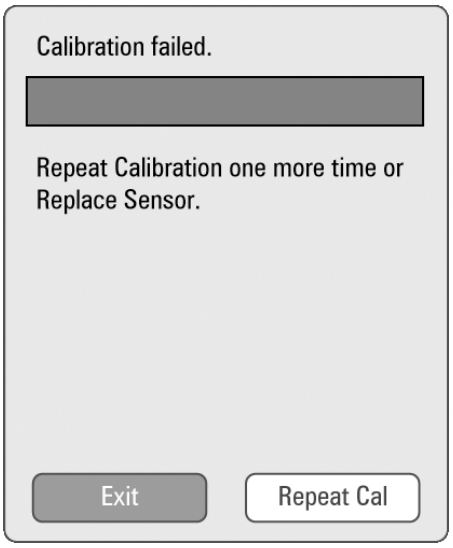


**FIGURE 2-19** Oxygen Sensor Calibration Failed

**17. Verify that the APNEA alarm activates in Manual mode**

**a.** Press the **MANUAL/AUTO** key.

**b.** After 60 seconds, verify that:

- an alarm tone sounds
- the alarm message APNEA is displayed in red text

**18. Verify that CMV ADULT ventilator mode operates and that the tidal volume display reads within 15% of the CMV set value.**

**a.** Attach a breathing circuit and breathing bag.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**b.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**c.** Attach a Vent Tester between the EXP port and the expiratory hose.

**d.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**e.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | CMV |
| Tidal Volume - $\mathbf{V_T}$ | 600 |
| Breath Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - $\mathbf{T_P}$ | 10 |
| PEEP - **PEEP** | Off |

**f.** Select **CMV** again to begin ventilation.

**g.** Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.

**h.** Verify the Tidal Volume display is within 15% of the delivered volume measured with the Vent Tester within approximately 1 minute from the start of ventilation.

**i.** Verify the delivered volume at the Vent Tester is within 15% of the Tidal Volume set value within approximately 1 minute from the start of ventilation.

**j.** Verify the measured $O_2$ concentration is at least 97% after 5 minutes.

**k.** Set the AIR flow to 3 L/min and set the $N_2O$ and $O_2$ flow rates to minimum flow.

**l.** Verify the measured $O_2$ concentration is 21% ±3% vol. % after 5 minutes.

**19. Verify that CMV CHILD ventilator mode operates and that the tidal volume display reads within 10% of the CMV set value.**

**a.** Attach a breathing circuit and breathing bag.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**b.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**NOTE:** **Limit the volume in the test lung to provide sufficient airway pressure to satisfy the Low Peak Pressure alarm. Or reduce the Peak Pressure alarm limit to a lower valve to prevent the alarm when using an adult test lung.**

**c.** Attach a Vent Tester between the EXP port and the expiratory hose.

**d.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**e.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Child |
| Ventilation Mode | CMV |
| Tidal Volume - **$V_T$** | 120 |
| Breath Rate - **freq** | 20 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - **$T_P$** | 10 |
| PEEP - **PEEP** | Off |

**f.** Select **CMV** to begin ventilation.

**g.** Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.

**h.** Verify the Tidal Volume display is within 25 ml or ±15% of the delivered volume (whichever is greater) measured within approximately 1 minute from the start of ventilation.

**i.** Verify the delivered volume as measured by a Vent Tester at the expiratory port, is within 17% of the Tidal Volume set value within approximately 1 minute from the start of ventilation.

**j.** Verify that the PEEP reading is 4 ±2 within approximately 1 minute from the start of ventilation.

**20. Verify that the PCV ADULT ventilator mode operates.**

**a.** Attach a breathing circuit and breathing bag.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**b.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**c.** Attach a Vent Tester between the EXP port and the expiratory hose.

**d.** Set the $O_2$ flow to 3 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**e.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | PCV |
| Target Pressure - $\mathbf{P_{TARGET}}$ | 20 |
| Breath Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| PEEP - **PEEP** | Off |
| Inspiratory Slope - $\mathbf{T_{slope}}$ | 0.5 |

**f.** Select **PCV** to begin ventilation.

**g.** Verify the Peak Pressure reading of the display is ±20%, at least 2 $cmH_2O$ of the Peak Pressure measured with the Vent Tester.

**h.** Verify that the pressure waveform, Tidal Volume, Resp. Rate and minute volume values appear on the screen.

**i.** Verify that the PEAK Value reaches 20 ±4 $cmH_2O$ within five breaths from the start of ventilation.

**21. Verify that the Low Airway Pressure alarm activates.**

**a.** While the ventilator is running disconnect the Inspiratory hose.

**b.** Verify that the "Low Airway Pressure" and the "APNEA" message appear on the screen.

**c.** Reconnect the hose to the Inspiratory port and verify that the alarm is cleared.

**22. Verify that the $O_2$ concentration alarm signals activate.**

**a.** While the ventilator is running, press the **ALARM LIMITS** key.

**b.** Set the $O_2$ Minimum Alarm Limit to a value higher than the current $O_2$ reading.

**c.** Verify that the $FiO_2$ alarm activates indicated by an audio tone is present and that the alarm message "Low $FiO_2$" appears on the screen within three ventilation cycles.

**d.** Set the $O_2$ Minimum Alarm Limit back to a value lower than the current $O_2$ reading.

**e.** Verify that the $FiO_2$ alarm resets.

**23. Verify that the drive gas pressure loss alarm signals activate and $N_2O$ stops and AIR continues to flow.**

- **a.** Set the $O_2$ flow for 1 L/min.
- **b.** Set the $N_2O$ flow to 1 L/min.
- **c.** Set the AIR flow to 1 L/min.
- **d.** Disconnect the $O_2$ line supply to the **AS3000**, and Close the $O_2$ cylinder.
- **e.** Verify that the flow of $N_2O$ stops when $O_2$ is lost.
- **f.** Verify that AIR continues to flow.
- **g.** Verify the "$O_2$ Supply Failure" message appears on screen, a steady audio tone should sound.
- **h.** Reconnect $O_2$ line pressure source to the **AS3000**.
- **i.** Verify that the alarms are reset.
- **j.** Verify $N_2O$ flow has resumed once $O_2$ pressure returns.

**24. Verify that the battery operation and charging icons appears.**

- **a.** Set the vent mode to Standby.
- **b.** Disconnect AC line cord.
- **c.** Verify that the battery icon appears on the screen and indicates the charge level of the battery.
- **d.** Verify that the line cord icon is flashing.
- **e.** Verify that the flow meter backlight is illuminated during battery operation.
- **f.** When the battery icon is in a not full state, reconnect the AC line cord.
- **g.** Verify that the battery charge icon appears on the screen.
- **h.** Verify that the flow meter backlight is illuminated during AC voltage operation.

**25. Verify operation of the work light.**

- **a.** Turn on the work light located on the bottom side of the top panel.
- **b.** Verify that it lights in both on positions.

**26. Verify that the Auxiliary $O_2$ and AIR Flowmeters operates.**

- **a.** Verify an AIR flow of 15 L/min can be obtained by connecting the auxiliary AIR hose to the pressure source and opening the flow meter.
- **b.** Verify an $O_2$ flow of 15 L/min can be obtained by connecting the auxiliary $O_2$ hose to the pressure source and opening the flow meter.

**27. Verify that the Suction Regulator operates in LINE and REGULATE positions.**

- **a.** Set the suction regulator's selection dial to **LINE**.
- **b.** Verify maximum suction vacuum on the regulator's gauge.
- **c.** Set the suction regulator's selection dial to **REGULATE**.
- **d.** Verify the suction vacuum is adjustable on the regulator's gauge.
- **e.** Set the suction regulator's selection dial to **OFF**.

**28. Verify that the Breathing System heats to body temperature.**

**a.** Operate the **AS3000** on AC operation for approximately 40 minutes.

**b.** Verify the Breathing System has heated up to body temperature

**29. Complete electrical safety inspection.**

**NOTE: Perform the electrical safety inspection as the last step after completing a repair or after routine maintenance. Perform this inspection with all covers, panels, and screws installed.**

**a.** Withdraw the Power cable(s) from the convenience receptacles at the rear of the **AS3000**.

**b.** Plug the **AS3000** into a Safety Analyzer.

**c.** Connect the case ground lead of the analyzer to the U-blade ground of one of the convenience receptacles. Perform the following tests with the case grounded:

- Normal polarity
- Normal polarity with open neutral

**d.** Perform the following tests with the case ungrounded:

- Normal polarity
- Normal polarity with open neutral
- Reverse polarity

**e.** Verify that the maximum leakage current does not exceed 300 µA (0.3 mA).

**NOTE: Ground Resistance (between the U-blade ground on any convenience outlet to the U-blade ground on the AC line cord).**

**f.** Plug the **AS3000** into the safety analyzer.

**g.** Attach the resistance-measuring probe on the analyzer to the **AS3000** U-blade ground on any convenience outlet.

**h.** Invoke the resistance function on the safety analyzer, following the instructions for the analyzer.

**i.** Verify that resistance to ground is less than 0.2 Ohms (200 mOhms).

**30. Check the vaporizer interlock.**

**a.** Attach two vaporizers to the Vaporizer Mounting Manifold and lock them in place.

**b.** Rotate either of the vaporizer's dial to **3%** agent.

**c.** Verify that the other vaporizer dial cannot be rotated to a setting.

**d.** Set both vaporizer's dials to **0**.

**e.** Rotate the other vaporizer dial to **3%**.

**f.** Verify that the first vaporizer dial cannot be rotated.

**g.** Rotate both vaporizer dials to **T** and remove both vaporizers.

**h.** Verify that the locking spring is intact.

**i.** Reconnect both vaporizers to the Vaporizer Mounting Manifold

**31. Check each vaporizer's agent concentration output and accuracy.**

**a.** Insert the agent measuring device sampling tube inside the common gas outlet port.

**b.** Fill the Vaporizer with anesthetic agent.

**NOTE: Do not overfill by filling past the indicator line on the vaporizer.**

**c.** Test the vaporizer accuracy per the Vapor 2000 instructions or see the appropriate vaporizer manual for testing details.

**d.** Test each vaporizer in turn.

**e.** Test any vaporizer on the Vaporizer Storage Mount.

**f.** Remove the measuring device from the common gas outlet port.

**g.** Connect the fresh gas tube to the common gas outlet port.

**32. Dräger Vapor 2000 Operating Instructions ARRB-F001.**

**a.** Fill Vaporizer - at least half full between minimum and maximum mark.

**b.** Allow the filled Vapor to warm up to room temperature of 20-24°C. Wait long enough for the temperature to equalize - the time will vary depending on the temperature differential '$\Delta$**T**'.

- 1 hour = up top 2°C
- 3 hours = ±6°C
- 4 hours = ±10°C
- 5 hours = ±20°C

**c.** Check anesthetic agent monitor. Perform zero calibration of monitor with the desired gas (AIR or $O_2$)

**d.** Connect monitor to fresh gas outlet or Y-fitting. Make sure that all connections are leak-tight.

**e.** Connect and start scavenging system.

**f.** Switch OFF ventilator or set vent pressure to less than 5 $cmH_2O$.

**g.** Set monitor to anesthetic agent being used and to continuous measurement.

**h.** Set flow between 2.5 and 4 L/min AIR. Use $O_2$ if AIR is not available.

**i.** Check **0** and **T** marks, 1 vol.% 4 vol % and at least three other concentrations.

**j.** Adjust control dial on the vaporizer.

**k.** Read concentration after it has reached steady state.

**l.** Correct measured values for the effect of carrier gas used. If AIR no correction required. If $O_2$ use following correction factor:

- Measured value vol.% = <1.0, correction = -0.05 vol.%
- Measured value vol.% = 1.0 - 2.0, correction = -0.1 vol.%
- Measured value vol.% = 2.5 - 4.0, correction = -0.2 vol.%
- Measured value vol.% = 5.0 - 8.0, correction = -0.3 vol.%

**m.** If the value displayed on the monitor is in % partial pressure, no correction is required. If in vol.% convert to partial pressure:

- Concentration [% partial pressure] = measured value [vol.%] x atmospheric pressure [$cmH_2O$] / 1013 $cmH_2O$

**n.** For setting **0** and **T** there should be no output of anesthetic agent.

- At 1 vol.%; 0.8 - 1.2 vol.% *
- At 2 vol.%; 1.8 - 2.2 vol.% *
- At 3 vol.%; 2.8 - 3.2 vol.% *
- At 4 vol.%; 3.8 - 4.2 vol.% *
- At 5 vol.%; 4.8 - 5.2 vol.% *
- At 6 vol.%; 5.7 - 6.3 vol.% *
- At 7 vol.%; 6.7 - 7.3 vol.% *
- At 8 vol.%; 7.7 - 8.3 vol.% *

* = Correct for temperature and carrier gas if necessary.

**o.** Switch off the vaporizer until **0** engages.

**p.** Switch off the AIR or $O_2$ flow.

# 3.0 *Repair Information*

## 3.1 Introduction

This chapter of the Service Manual provides the necessary technical information to perform repairs to the system. The most important prerequisites for effective troubleshooting are a thorough understanding of the system's functions, as well as understanding its principles of operation.

# 3.2 Warnings and Cautions

In the event the instrument covers are removed, observe the following warnings and cautions:

## 3.2.1 Warnings

**WARNING: Whenever using anesthetic gases, nitrous oxide, oxygen, or any hospital gas always follow the appropriate agent evacuation/collection procedures. Use the hospital gas evacuation system.**

## 3.2.2 Cautions

**CAUTION: This device uses high pressure compressed gas. When attaching or disconnecting backup gas cylinders, always turn the cylinder valves slowly. Use the AS3000 flow meters to bleed down the pressure, watching the cylinder gauge indicate the depleting cylinder pressure, before disconnecting the cylinder from the yoke. Always open and close cylinder valves fully.**

**CAUTION: This device operates using compressed gas at high pressures from the hospital central supply. When connecting gas supply lines attach the hose connection to the machine before connecting the quick disconnect fitting to the hospital source. Disconnect the supply hose from the hospital source connection prior to disconnecting it from the AS3000 gas connection fittings.**

# 3.3 Troubleshooting Guidelines

1. **Identify the problem** — Due to the wide variety of potential symptoms, certain problems may be more subtle than others. Following the guidelines of the tests will help determine the problem, if one exists.
2. **Avoid shorting component leads together** — During repair procedures, it can be tempting to make a quick series of measurements. Always turn the power off before connecting and disconnecting the test leads and probes. The accidental shorting of leads can easily stress the components and cause a second failure (aside from the safety risk).
3. **Use the proper equipment** — The equipment listed in "Special Tools Required" on page 3-3, is suggested to fulfill a wide range of troubleshooting requirements. It is imperative to use the designated equipment in order to ensure proper results of any and all test procedures.
4. **Clean up the repair area** — After any repair, clean off the repair area.

# 3.4 Special Tools Required

| | PART NUMBER | DESCRIPTION | SPECIFICATION |
|---|---|---|---|
| 1 | 0070-00-0683 | AS3000 Service Manual | NA |
| 2 | not applicable | Vaporizer Instruction Manual | NA |
| 3 | not applicable | Safety Analyzer | Dempsey 430 or equivalent |
| 4 | not applicable | Digital Volt Meter | 3 1/2 digit |
| 5 | not applicable | Agent (and $N_2O$) Analyzer | ±0.3 V/V% + 5% of reading |
| 6 | 0138-00-0012 | Test Lung, Adult | NA |
| 7 | not applicable | Digital Pressure Meter | BC Biomedical DPM-2301751 NMC Digital Pressure Meter |
| 8 | not applicable | Central supplied $O_2$, $N_2O$, AIR | Minimum of 35 psi, DISS connections. |
| 9 | not applicable | Cylinder gases O2, $N_2O$, AIR | Full PISS yoke connections. |
| 10 | not applicable | Hand tools, Allen wrench set | Metric |
| 11 | 0367-00-0080 | Tank Wrench | NA |
| 12 | 0103-00-0508 | Y-Fitting | 15 mm connection |
| 13 | 0004-00-0076 | Respiration Tube (2 required) | 0.6 meter silicone, 15 mm |
| 14 | 0992-00-0139 | Breathing Bag | 2.3 L silicone |
| 15 | 0510-00-0020 | Krytox Lubricant | NA |
| 16 | not applicable | Vent Tester | Certifier-FA PLUS Respiratory Vent.Tester 4080 |
| 17 | 0997-00-0641 | AS3000 Calibration hose | NA |
| 18 | 0103-00-0691 | AS3000 test plug | NA |
| 19 | 0040-00-0448 | Plug Kit | NA |
| 20 | 0453-00-1216 | Regulator Calibration Hose | NA |

# 3.5 Troubleshooting Chart

The following table shows common symptoms and corrective actions for problems when troubleshooting the **AS3000**. The information given indicates failures during startup and runtime.

## 3.5.1 Common Symptoms and Corrective Actions for Field Service Technicians

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| "BDU Communication . . . FAIL" | Startup test | 1 | The power supply switch is turned to ON, immediately after turned to OFF, which makes the time too short for the BDU control board power to reboot. | 1 | Turn the power supply switch to OFF and power on again after waiting for a while (1 - 2 seconds). |
| | | 2 | The data wire is disconnected or damaged. | 2 | Check whether the data wire (signal wire at backside of display) is disconnected or is damaged. |
| | | 3 | The BDU control board is defective. | 3 | Replace the BDU control board and perform each item of calibration and startup test again. |
| "Software Version . . . FAIL" | Startup test | 1 | Software versions of GUI, BDU and Keyboard are incompatible. | 1 | Update software version. |
| | | 2 | The power supply switch was turned ON, and OFF quickly. | 2 | Turn the power supply switch to OFF, wait 1 -2 seconds, then power on again. |
| | | 3 | The data wire is disconnected or damaged. | 3 | Check whether the data wire (signal wire at backside of display) is disconnected or is damaged. |
| | | 4 | The BDU control board is defective. | 4 | Replace the BDU control board and perform each item of calibration and startup test again. |
| | | 5 | The keyboard board is defective. | 5 | Replace the user interface assembly. |
| "BDU EEPROM Data . . . FAIL" | Startup test | 1 | Data stored in EEPROM on BDU control board is lost (checksum error) | 1 | Startup. Then perform each item of the calibration and startup test again. |
| | | 2 | The BDU is defective | 2 | Replace the BDU board |
| "EEPROM IC . . . FAIL" | Startup test | 1 | The BDU control board is defective or its EEPROM is damaged. | 1 | Check that the EEPROM (BDU U12) is connected correctly, or Replace the EEPROM and BDU control board, and perform each item of the calibration and startup test again. |
| "BDU WDT . . . FAIL" | Startup test | 1 | The Watch Dog Timer in the digital signal processor on the BDU control board is damaged. | 1 | Replace the BDU control board, and perform each item of calibration and startup test again. |
| "AD/DA . . . FAIL" | Startup test | 1 | The AD or 4052 in the digital signal processor on BDU control board is damaged. | 1 | Replace the BDU control board, and perform each item of the calibration and startup test again. |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| "Vent/Manual Valve Failure" | Startup test | 1 | The wire that connects to the vent/manual valve is disconnected or is damaged. | 1 | Check whether the connection wire of the vent/manual valve is disconnected or is damaged. |
| | | 2 | The vent/manual solenoid valve is damaged. | 2 | Replace the vent/manual solenoid valve. |
| | | 3 | The amplifier board or connection cable defective. | 3 | Check the connection cable and replace the amplifier board. Then perform each item of the calibration and startup tests again. |
| "Expiration Sensor Failure" | Startup test | 1 | Fresh gas flow is present at startup. | 1 | Turn off all fresh gas flow and reboot the unit. |
| | | 2 | The sensor board is defective. | 2 | Replace the sensor board, and then perform each item of the calibration and startup test again. |
| "Keyboard Communication . . . FAIL" | Startup test | 1 | The data wire is disconnected or is damaged. | 1 | Replace the user interface assembly. |
| | | 2 | The keyboard board is defective. | 2 | Replace the user interface assembly. |
| "Pressure Sensor . . . FAIL" | Startup test | 1 | The connection wire of the PAW board is disconnected or is damaged. | 1 | Check whether the connection wire of the PAW board is disconnected or damaged. |
| | | 2 | The connection of the PAW board or sensor board is defective. | 2 | Check the power supply and connection of the sensor board. Replace the Paw board and sensor board. |
| | | 3 | The tubing kinked or occluded. | 3 | Check the tubing for kinks and remove any occlusions. |
| "$O_2$ Sensor . . . FAIL" | Startup test | 1 | The $O_2$ concentration is below 16%. | 1 | Increase $O_2$ concentration. |
| | | 2 | The oxygen sensor is out of range. | 2 | Replace the oxygen sensor. |
| | | 3 | The main unit-oxygen sensor cable is disconnected or damaged. | 3 | Check whether the main unit-oxygen sensor cable is disconnected or damaged. |
| | | 4 | The amplifier board is defective. | 4 | Replace the amplifier board, and then perform each item of the calibration and startup test again. |
| "PEEP Valve . . . FAIL" | Startup test | 1 | The connection wire of the PEEP valve is disconnected or damaged. | 1 | Check whether the PEEP valve is disconnected or damaged. |
| | | 2 | The PEEP valve is defective. | 2 | Replace the PEEP valve. |
| | | 3 | The Amplifier board is defective. | 3 | Replace the amplifier board and then perform each item of the calibration and startup test again. |
| "Inspiration Valve . . . FAIL" | Startup test | 1 | The connection wire of the inspiration valve is disconnected or damaged. | 1 | Check whether the inspiration valve is disconnected or damaged. |
| | | 2 | The inspiration valve is defective. | 2 | Replace the inspiration valve. |
| | | 3 | The amplifier board is defective. | 3 | Replace the amplifier board and then perform each item of the calibration and startup test again. |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| "Inspiration Sensor . . . FAIL" or "Inspiration Sensor . . . FAIL Try re-starting the system with all gas flows OFF" (UI version 2.25 and higher) | Startup test | 1 | Fresh gas is flowing during the startup procedure. | 1 | Verify that no fresh gas is flowing during the startup procedure. |
| | | 2 | The tubing kinked or occluded. | 2 | Check the tubing for kinks and remove any occlusions. |
| | | 3 | The sensor board is defective. | 3 | Replace the sensor board and then perform each item of the calibration and startup test again. |
| "$O_2$ Supply . . . FAIL" | Startup test<br>Runtime | 1 | The gas source is not connected. | 1 | Check gas source. |
| | | 2 | The gas supply pressure switch or its cable is damaged. | 2 | Check and replace the switch or cable of the gas source. |
| | | 3 | The amplifier board is defective. | 3 | Replace the amplifier board, and then perform each item of the calibration and startup test again. |
| "AC Power Failure" | Startup test<br>Runtime | 1 | AC power is not connected. | 1 | Check the connection of AC power. |
| | | 2 | A fuse is tripped | 2 | Replace the fuse. |
| "Low Battery" | Runtime | 1 | Battery capacity is low. | 1 | Charge the battery by connecting AC power. |
| | | 2 | The battery is defective. | 2 | Replace the battery. |
| | | 3 | The connection wire or power board is defective. | 3 | Check the connection wire or replace the power board. |
| "Alarm Speaker . . . FAIL" | Startup test | 1 | The connection wire to the speaker is disconnected or damaged. | 1 | Check whether the connection wire of the speaker is disconnected or damaged. |
| | | 2 | The speaker is damaged. | 2 | Replace the user interface assembly. |
| | | 3 | The keyboard board is defective. | 3 | Replace the user interface assembly. |
| "Software Mismatch" or "Software Mismatch or Failure to Shut Down Completely" (UI version 2.25 and higher) | Startup test | 1 | Power is recycled to the unit too quickly, not allowing the memory to fully clear. | 1 | Shut down the unit and wait until the backlight is fully extinguished before restoring power. |
| Charging state is always displayed. | Runtime | 1 | Battery capacity is low. | 1 | Charge the battery by connecting AC power. |
| | | 2 | The connection wire to the battery is disconnected or damaged. | 2 | Check whether the connection wire to the battery is disconnected or damaged. |
| | | 3 | The battery is defective. | 3 | Replace the battery. |
| During startup leak test, the bellows moves when it shouldn't | Startup test | 1 | A solenoid failure or wiring error. | 1 | Correct the wiring or replace the solenoid valve. |
| In leakage detection, The APL Valve detection pressure displayed on the pressure gauge does not stay within 28 - 32 $cmH_2O$. | Startup test | 1 | The Breathing System pneumatic hose leaks gas when in manual mode. | 1 | Replace the Breathing System pneumatic hose |
| | | 2 | Pressure gauge failure. | 2 | Replace the pressure gauge |
| | | 3 | The APL Valve is out of spec | 3 | Replace the APL Valve |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| In leakage detection, Safety valve detection failed. | Startup test | 1 | The proportional valve on the airway module failed. | 1 | Calibrate the inspiration valve again. |
| | | 2 | The safety valve in the airway module failed. | 2 | Replace the airway module. |
| In leakage detection, the leakage volume is 501 - 999mL. | Startup Test | 1 | The tubing connection is not tight. | 1 | Check the connection on the tubing. |
| | | 2 | Incorrect installation of the absorber canister. | 2 | Check the installation of the absorber canister. |
| | | 3 | The pressure gauge or oxygen sensor on the circuit is not installed tightly. | 3 | Check the installation of the pressure gauge or oxygen sensor on circuit. |
| | | 4 | There is a leakage in the fresh gas supply. | 4 | Check the fresh gas supply for leakage |
| In leakage detection, the leakage volume is larger than 1L. | Startup Test | 1 | The tubing connection is not tight. | 1 | Check the connection on the tubing. |
| | | 2 | Incorrect installation of the absorber canister. | 2 | Check the installation of the absorber canister. |
| | | 3 | The pressure gauge or oxygen sensor on the circuit is not installed tightly. | 3 | Check the installation of the pressure gauge or oxygen sensor on circuit. |
| | | 4 | There is a leakage in the fresh gas supply. | 4 | Check the fresh gas supply for leakage |
| In compliance test, compliance test failed. | Startup Test | 1 | The Y-fitting is not sealed or the Breathing System has leakage. | 1 | Check the connection and leakage of respiration tubes. |
| | | 2 | The respiration tubes are too long. | 2 | The respiration tubes cannot be too long. |
| | | 3 | Calibration of the pressure sensor is inaccurate. | 3 | Calibrate the pressure oxygen again. |
| | | 4 | The flow meter is set incorrectly | 4 | Set the flow meter to the correct value |
| | | 5 | The calibration of the flow meter is inaccurate | 5 | Recalibrate the flow meter |
| The power supply switch on the main unit is defective. | All | 1 | The power supply switch on the main unit or the cable connection failed. | 1 | Check the connection cable of the power supply switch of the main unit, or replace the power supply switch of main unit. |
| | | 2 | Communication board is defective. | 2 | Replace the communication board. |
| All or some keys are non responsive. | All | 1 | The keyboard is defective. | 1 | Replace the user interface assembly. |
| | | 2 | The communication board is defective. | 2 | Replace the user interface assembly. |
| The encoder is non responsive. | All | 1 | The encoder failed. | 1 | Replace the user interface assembly. |
| | | 2 | The communication board is defective. | 2 | Check and replace the user interface assembly. |
| All or some of the work lights are defective. | All | 1 | The work light circuit board is defective. | 1 | Replace the work light circuit board. |
| | | 2 | The cable is defective | 2 | Check the connection to the power supply. |
| The switch on the work light is defective. | All | 1 | The switch on the work light is defective. | 1 | Replace the work light switch. |
| The flow meter light is non operational. | All | 1 | The power supply to the light is defective | 1 | Replace the power supply to the light. |
| | | 2 | The foil of light is defective. | 2 | Replace the foil of light. |
| | | 3 | The inverter is defective. | 3 | Replace the inverter |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| Heating of circuit is non functional. | Runtime | 1<br>2<br>3 | Line power is not connected.<br>The circuit cable is defective.<br>Heating control board is defective. | 1<br>2<br>3 | Check the line power connection.<br>Replace the cable connection to the circuit.<br>Replace the heating control board. |
| AC Outlets are non functional | All | 1 | A fuse is tripped | 1 | Replace the fuse |
| The $O_2$ reading is out of tolerance | Runtime | 1 | The calibration of the oxygen sensor is inaccurate, or the oxygen sensor is defective. | 1 | Calibrate the oxygen sensor again, or replace the oxygen sensor. |
| The display screen has a hotspot or uneven brightness | All | 1<br>2 | The display screen is defective.<br>PC104 is defective. | 1<br>2 | Replace the user interface assembly.<br>Replace the user interface assembly. |
| The display screen is a solid color | Startup Test<br>Runtime | 1<br>2<br>3<br>4<br>5 | The GUI program has crashed.<br>The signal cable is disconnected.<br>PC104 is defective.<br>The communication board or power supply for the light is defective.<br>The display screen is damaged. | 1<br>2<br>3<br>4<br>5 | Reboot the system<br>Check the signal cable.<br>Replace the user interface assembly.<br>Replace the user interface assembly.<br>Replace the user interface assembly. |
| The pressure reading is out of tolerance | Runtime | 1 | Calibration of the pressure sensor is out of spec. | 1 | Calibrate the pressure sensor again. |
| The PEEP reading is out of tolerance | Runtime | 1<br>2 | Calibration of expiration valve (PEEP) is inaccurate.<br>Calibration of pressure sensor is inaccurate. | 1<br>2 | Calibrate the expiration valve (PEEP).<br>Calibrate the pressure sensor. |
| the tidal volume reading is out of tolerance | Runtime | 1<br>2<br>3<br>4 | The compliance test after startup is inaccurate.<br>Calibration of the flow sensor is inaccurate.<br>Calibration of the inspiration valve is inaccurate.<br>Calibration of the pressure sensor is inaccurate. | 1<br>2<br>3<br>4 | Perform the compliance test after startup again.<br>Calibrate the flow sensor again.<br>Calibrate the inspiration valve again.<br>Calibrate the pressure sensor again. |
| "System Self Test" | Startup Test | 1 | Self-test during each startup. | 1 | No action needed. |
| "NON-FUNCTIONAL Call Service Representative" | Startup Test | 1 | A failure has been found (Displayed on the screen), which leads to the abnormal operation of anesthesia machine. | 1 | Handle it according to specific information on the failure. |
| After the startup test, only the **MANUAL/AUTO** key is displayed, with the alarm: (except $O_2$ supply fail) | Startup Test | 1 | A failure has been found (Displayed on the screen), which leads to the abnormal operation of anesthesia machine. | 1 | Handle it according to specific information on the failure. |
| After the startup test, there are **Bypass** and **Continue** keys, but with an alarm displayed | Startup Test | 1 | A failure has been found (Displayed on the screen), but it does not affect the normal operation of each ventilation mode. | 1 | Handle it according to specific information on the failure. |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| "Ventilator setting is not possible!" | Runtime | 1 | A parameter has been set to a limit that can be set. | 1 | The parameter set cannot exceed the adjustable range. If the limit is not reached, another parameter may be limiting the range and needs to be adjusted accordingly |
| "Displayed parameter values are for the pending mode" | Runtime | 1 | The **AS3000** is in the pre-selection mode, but it is still working according to the original operating mode. | 1 | Set parameters 15 seconds in advance; or directly confirm and enter ventilation mode; or press the **NORMAL SCREEN** button to return to the original ventilation mode interface; or do not perform any operation and it will automatically return to the original ventilation mode interface after 15 seconds. |
| "Pressure, Volume and Apnea Alarms are OFF!" | Runtime | 1 | The functional alarm in Manual mode is disabled. | 1 | Enable the functional alarm in Manual mode. |
| "Automatic Ventilation not available!" | Startup Test<br>Runtime | 1 | A failure has been found (Displayed on the screen); the **AS3000** can work only in Standby/Manual mode. This information is displayed after entering the Main Screen. | 1 | Handle it according to specific information on the failure. |
| "BDU Communication Failure!" | Startup Test<br>Runtime | 1<br>2 | The communication cable is disconnected.<br>The BDU software has crashed or reset. | 1<br>2 | Check the communication cable.<br>Power on again. |
| "$O_2$ Sensor failure" | Runtime | 1 | The main unit-oxygen sensor cable is disconnected. | 1 | Check the unit-oxygen sensor cable. |
| "$O_2$ Supply failure" | Runtime | 1 | The gas source is closed or disconnected. | 1 | Check the gas source. |
| Continuous Pressure | Runtime | 1<br>2<br>3 | Airway pressure is too high.<br>The expiration valve (PEEP) is defective.<br>The airway is occluded. | 1<br>2<br>3 | Relieve the airway pressure<br>Repair/replace the expiration valve<br>Clear the occlusion |
| High Airway Pressure | Runtime | 1 | Airway pressure is high. | 1 | Adjust the upper limit set for the airway pressure alarm. |
| Low Airway Pressure | Runtime | 1 | Airway pressure is low. | 1 | Adjust the lower limit set for the airway pressure alarm. |
| Negative Pressure | Runtime | 1 | Airway pressure is continuously negative. | 1 | Check the airway and fresh gas setting |
| Low $FiO_2$ | Runtime | 1<br>2 | Oxygen concentration is lower than the lower limit set for Oxygen Concentration alarm.<br>Oxygen calibration is inaccurate. | 1<br>2 | Adjust the lower limit set for the Oxygen Concentration alarm or the actual oxygen concentration.<br>Calibrate the oxygen concentration sensor again. |

| MESSAGE/ISSUE | OCCURRENCE | CAUSE | | SOLUTION | |
|---|---|---|---|---|---|
| High $FiO_2$ | Runtime | 1<br>2 | Oxygen concentration is higher than the upper limit set for the Oxygen Concentration alarm.<br>Oxygen calibration is inaccurate. | 1<br>2 | Adjust the upper limit set for the Oxygen Concentration alarm or the actual oxygen concentration.<br>Calibrate the oxygen concentration sensor again. |
| APNEA | Runtime | 1 | Breathing hoses are disconnected. | 1 | Check the breathing hoses. |
| Low Battery | Runtime | 1 | Battery capacity is low. | 1 | Connect the unit to AC power. |
| High Minute Volume | Runtime | 1 | Minute ventilation is higher than the upper limit set for the Oxygen Concentration alarm. | 1 | Adjust the upper limit set for the Minute Ventilation alarm. |
| Low Minute Volume | Runtime | 1 | Minute ventilation is lower than the lower limit set for the Minute Volume alarm. | 1 | Adjust the lower limit set for the Minute Volume alarm. |
| APNEA Backup | Runtime | 1 | PS mode is not triggered and APNEA backup ventilation is given according to the minimum breathing frequency that has been set. | 1 | No action needed. |
| High PEEP | Runtime | 1<br>2 | The expiration time is too short or expiration limb is occluded<br>The expiration valve (PEEP) is defective. | 1<br>2 | Check the time setting and expiration pipeline.<br>Check the expiration valve (PEEP). |
| Keyboard communication Failure | Startup Test<br>Runtime | 1<br>2 | The signal wire is disconnected or damaged.<br>The keyboard board program crashed. | 1<br>2 | Check the signal wire.<br>Power on again. |
| AC Power Failure | All | 1 | AC power is not connected or a fuse is tripped. | 1 | Connect AC and check the fuses. |
| $O_2$ Cal Due | Startup Test<br>Runtime | 1 | The oxygen sensor has not been calibrated for more than 3 days. | 1 | Calibrate the oxygen sensor. |
| Tidal volume displayed by the **AS3000** is smaller than the value displayed on bellow. | Runtime | 1 | This caused by the compliance and compensation of resisting force between the airway and patient. | 1 | No action needed. |
| Bellows is deflated and at the bottom of its travel during runtime, after initial power-up and Leak Test. | Runtime | 1 | This is caused by a disconnected breathing circuit, a removed absorber canister, a removed $O_2$ sensor or sensor adapter, check valve dome rings, or no fresh gas flow while ventilator is running. | 1 | Install a breathing circuit and connect the Y-piece to the Test port. Select CMV mode and confirm the selection. Immediately push the $O_2$ Flush button until the bellows is completely filled. Return to STANDBY mode and remove Y-piece from Test port. |

# 3.6 Leak Troubleshooting

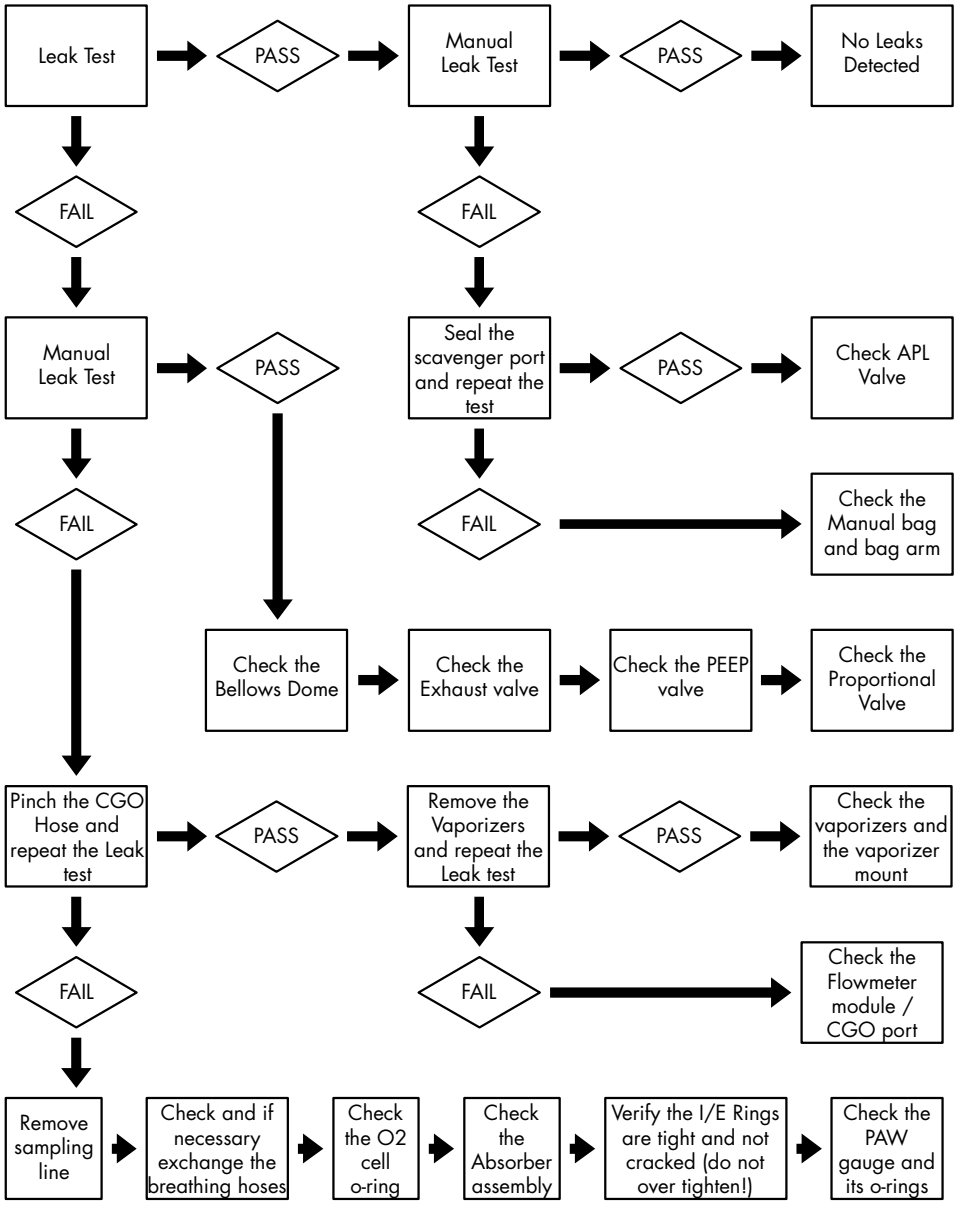


**FIGURE 3-1** Leak Troubleshooting Flow Chart

# 3.7 Test Pneumatics

The following section shows the pneumatic components involved while performing the **AS3000** startup tests.

## 3.7.1 Leak Test - Manual Ventilation Test

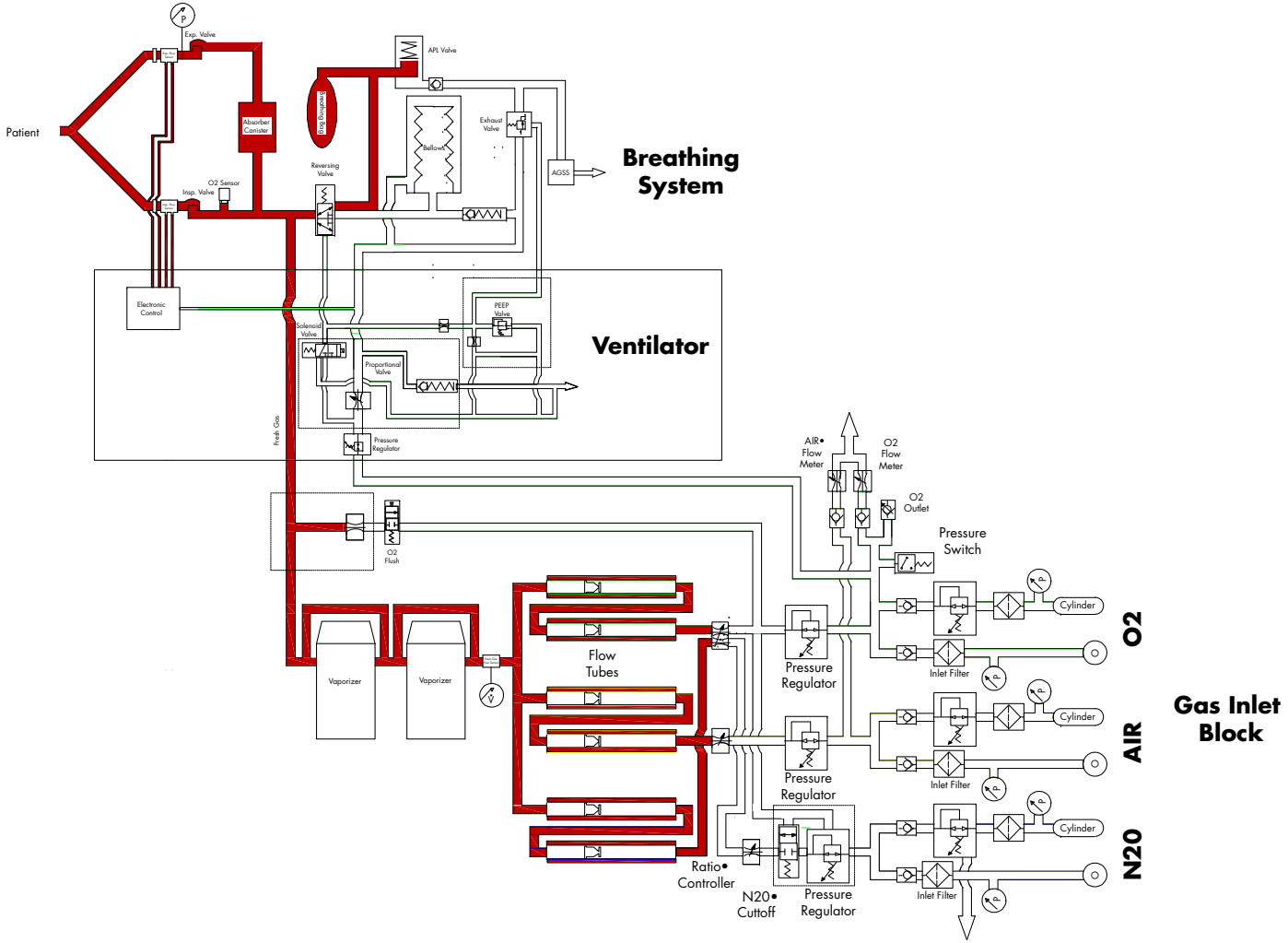


**FIGURE 3-2** Manual Ventilation Test Pneumatics

## 3.7.2 Safety Valve Test

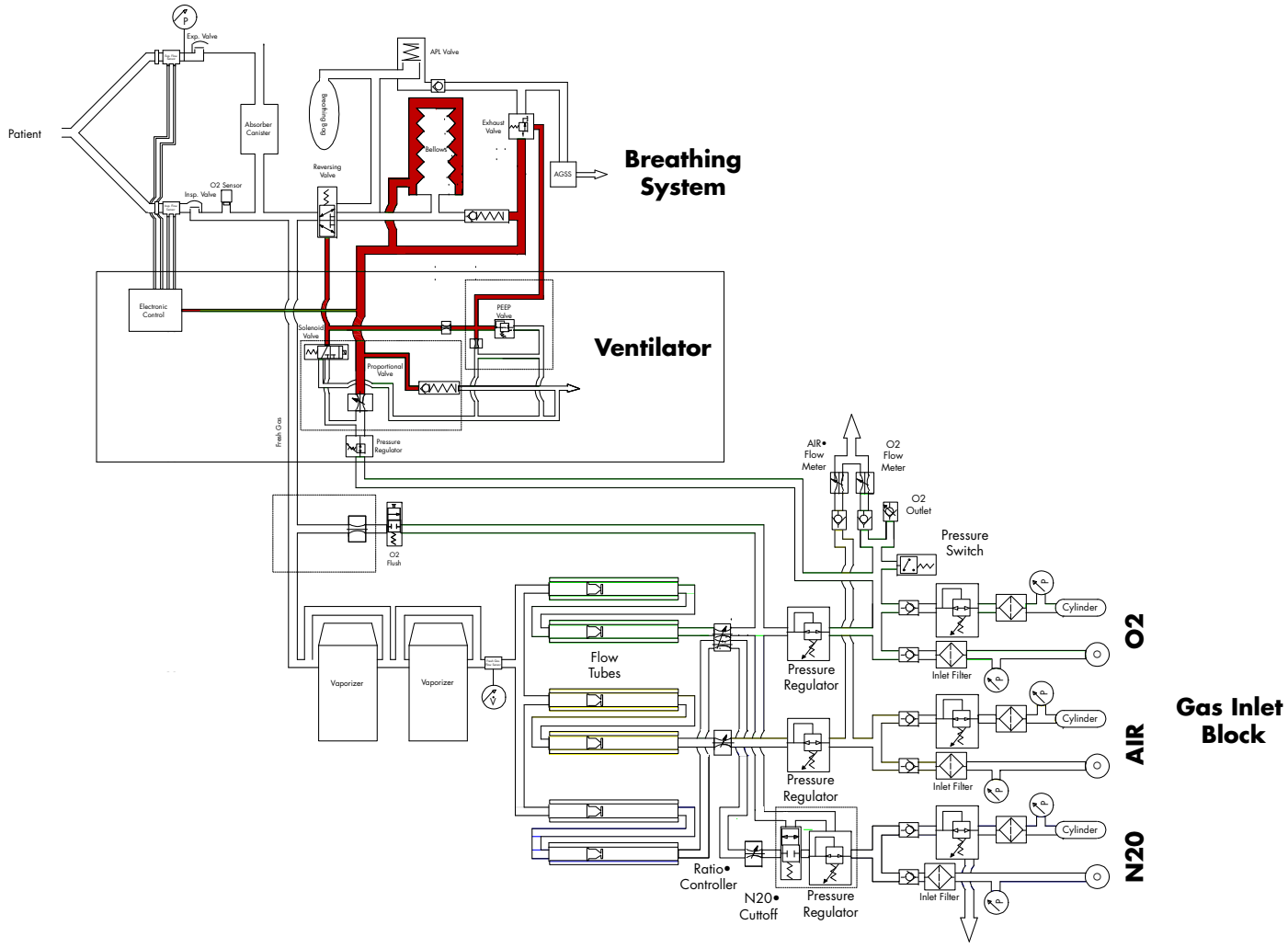


**FIGURE 3-3** Safety Valve Test Pneumatics

## 3.7.3 Leak Test - Automatic Ventilation Test

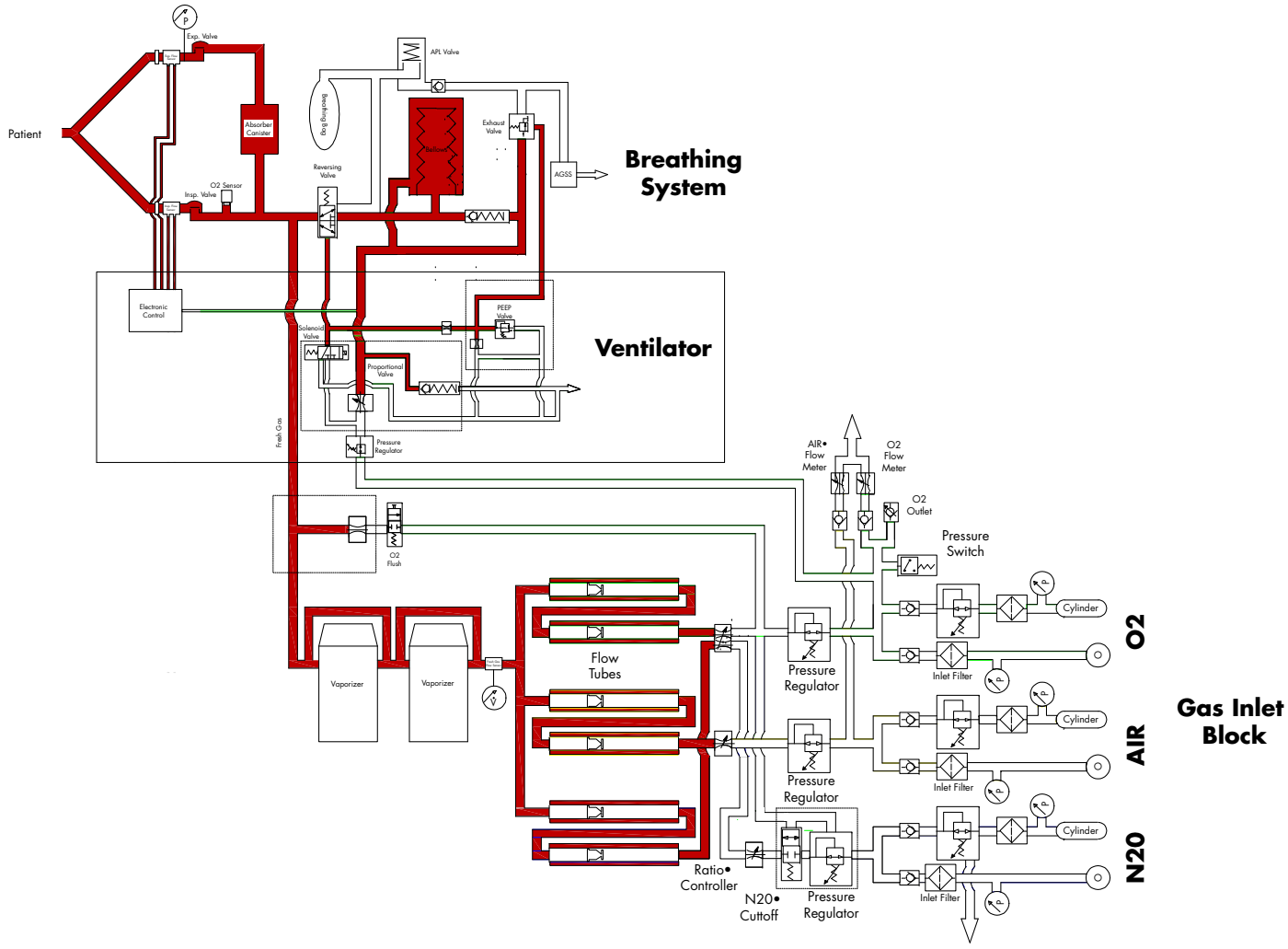


**FIGURE 3-4** Automatic Ventilation Test Pneumatics

## 3.7.4 Compliance Test

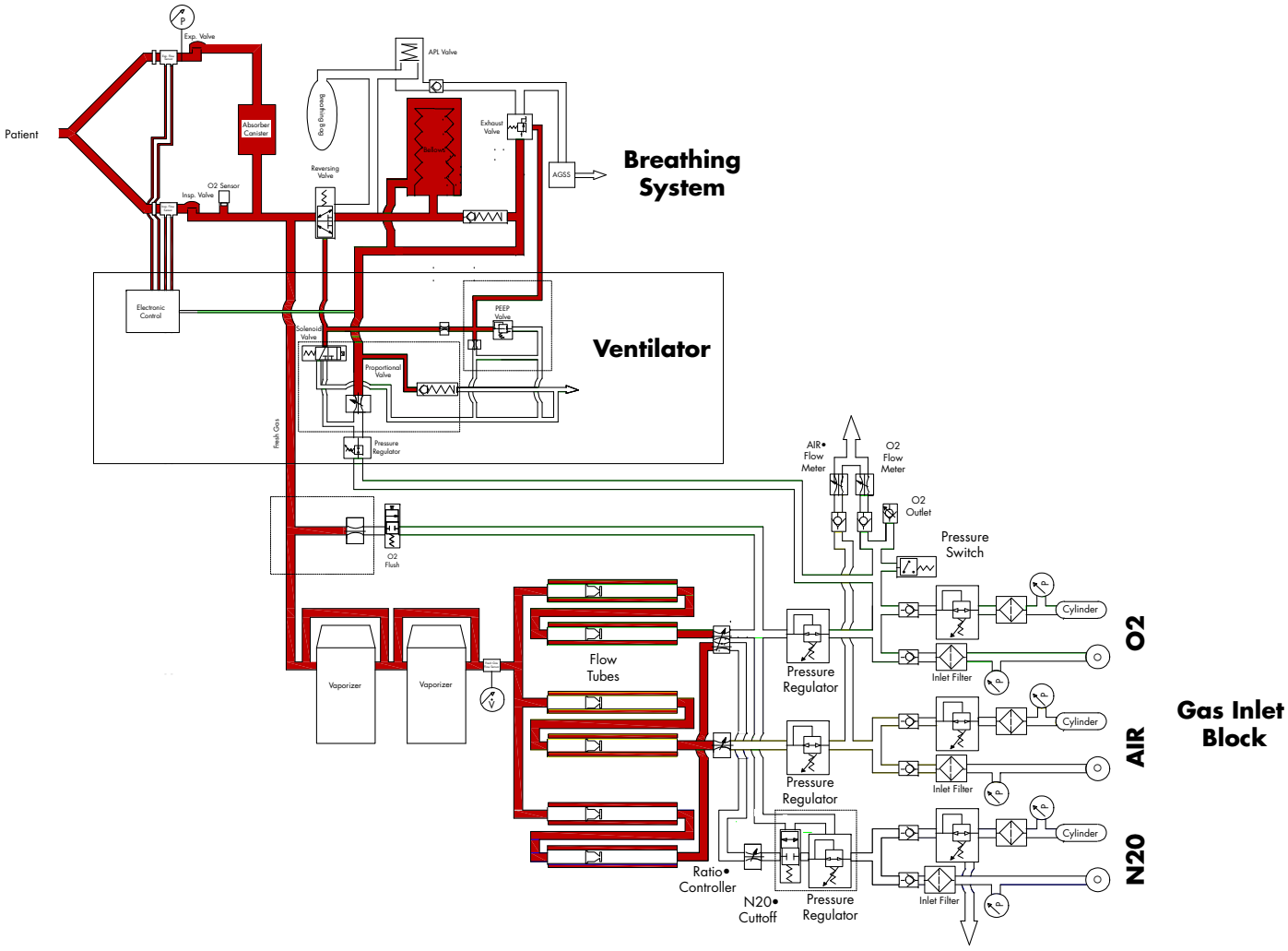


**FIGURE 3-5** Compliance Test Pneumatics

# 3.8 Pneumatic Hose and Wiring Diagrams

## 3.8.1 Pneumatic Hose Labeling

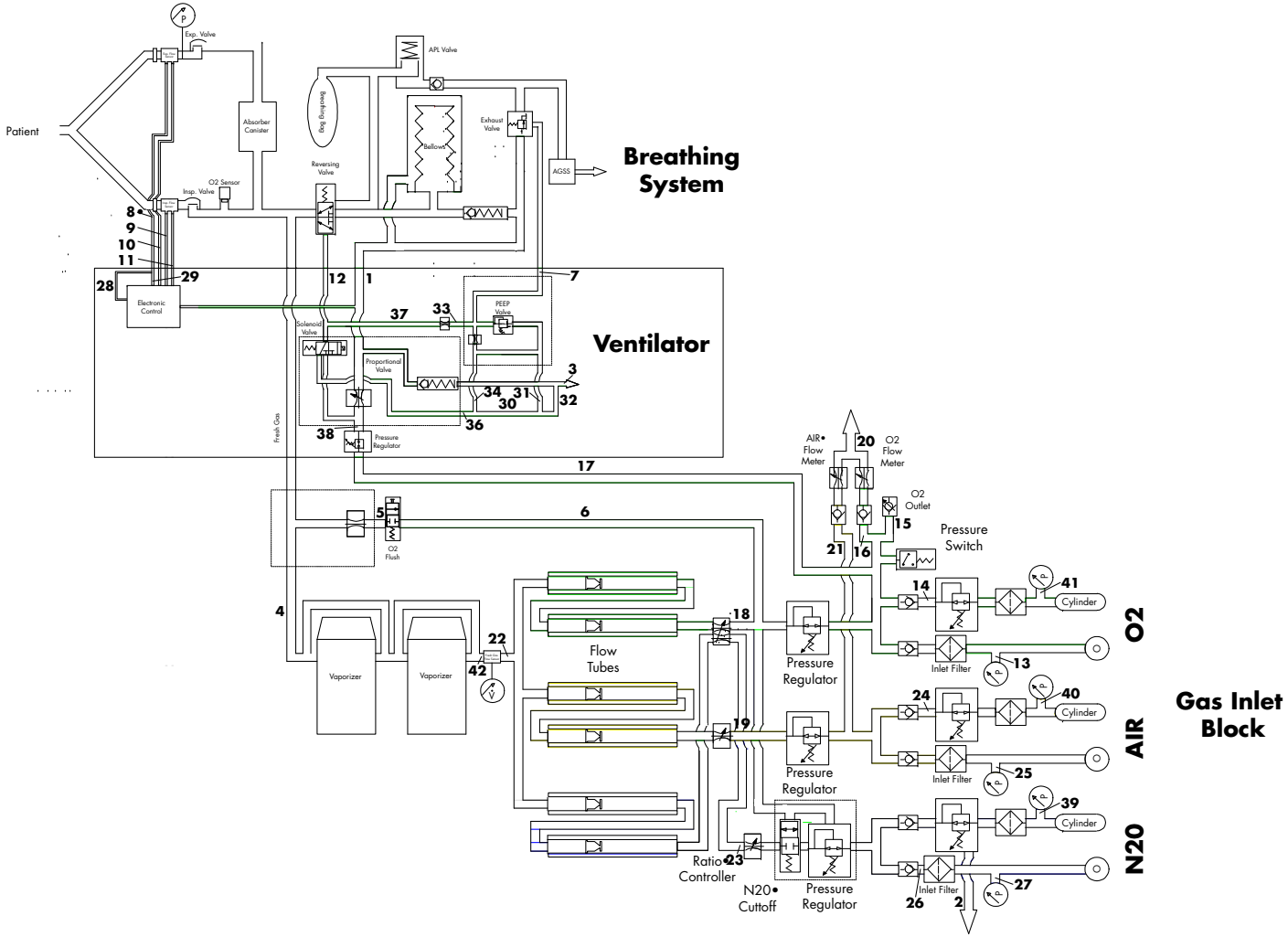


**FIGURE 3-6** Pneumatic Hose Labeling Diagram

## 3.8.2 Sampling Pipeline Module Interface Labeling

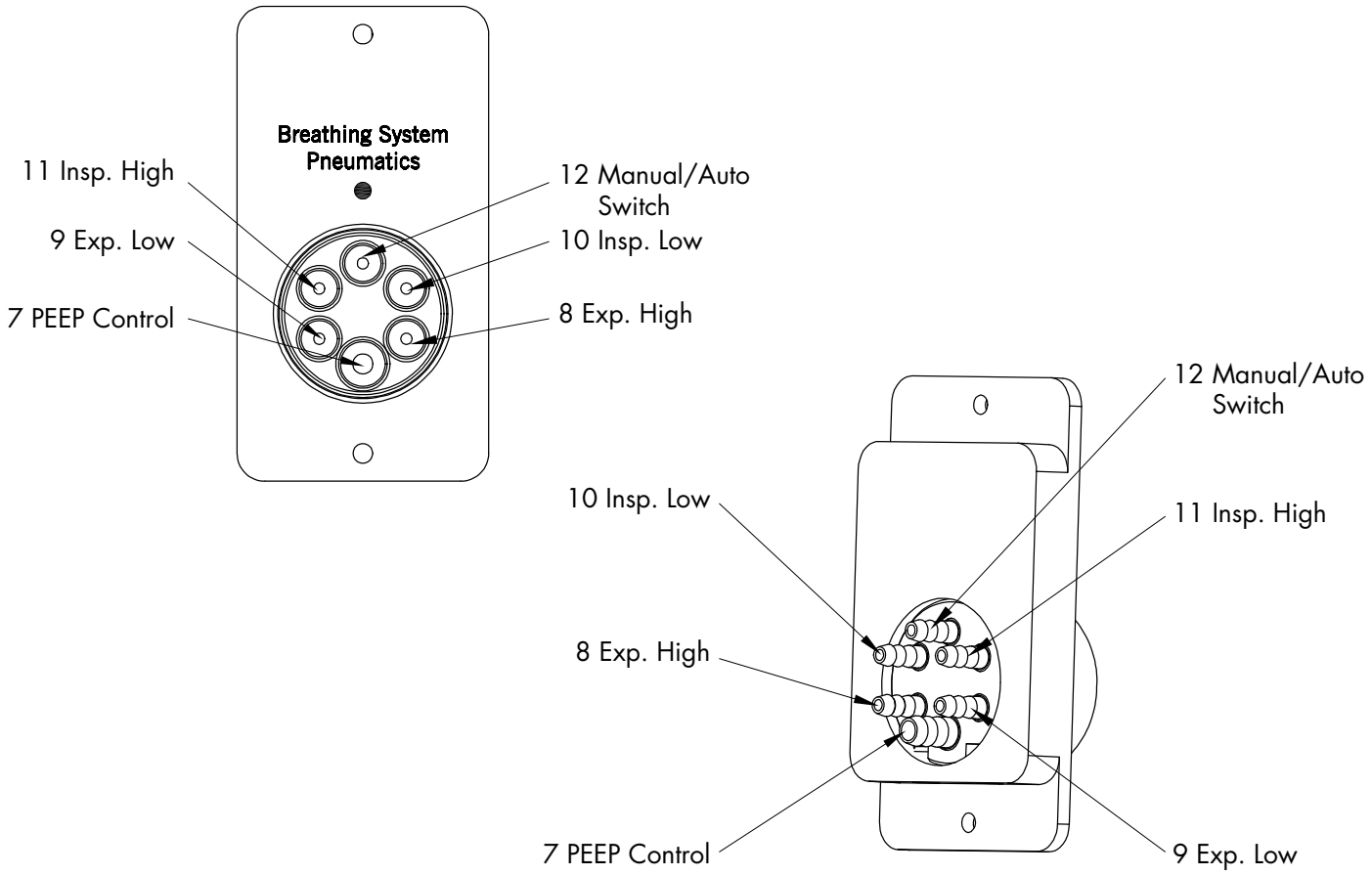


**FIGURE 3-7** Sampling Pipeline Module Interface Diagram

## 3.8.3 Electrical Cable Labeling

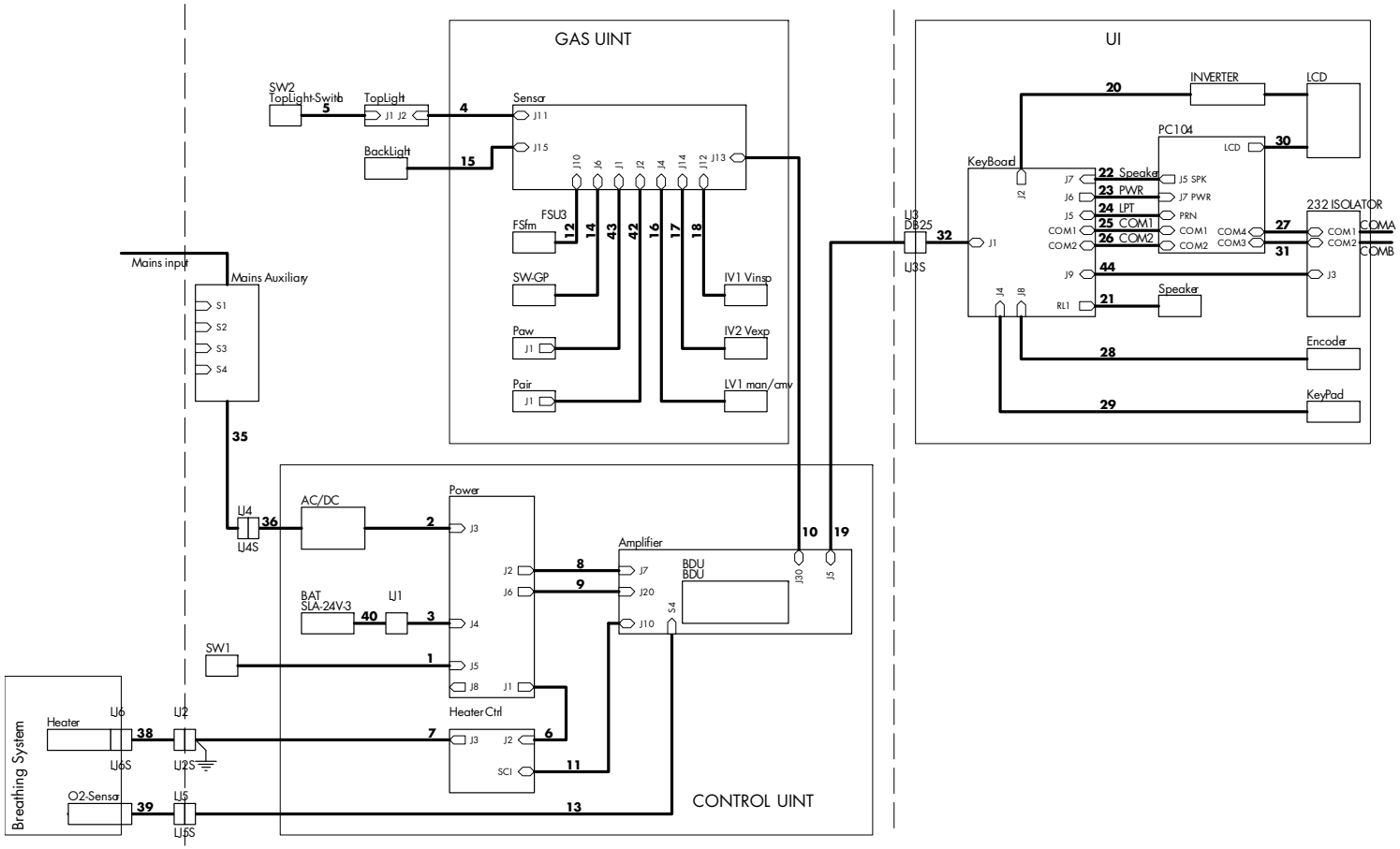


**FIGURE 3-8** Electrical Cable Labeling Diagram

# 4.0 *Replacement Parts and Accessories*

## 4.1 Introduction

This section of the manual provides information that is necessary to identify replacement parts and accessories.

## 4.2 Available Replacement Parts and Sub-Assemblies

The following part lists are divided into two sections. The Isometric Drawings and the accompanying part lists identify the available chassis mounted components.

### 4.2.1 Exchange Program

Mindray DS USA, Inc. offers an exchange policy for many of the printed circuit board assemblies. This program may provide the most expedient method of servicing the equipment. A standard charge is associated with this service. Contact the Service Department for details concerning this exchange program.

Many circuit boards make extensive use of multi-layer and surface mount technology. Individual component replacement is not recommended on these boards. Board exchange or replacement is the most efficient method of repair for these types of assemblies. Component level repair is not recommended.

Circuit boards, returned as parts of the exchange program, that show evidence of improper repair techniques are not considered for exchange. Damaged boards will be invoiced at full value and no exchange credit will be applied.

### 4.2.2 Replacement Parts Pricing Information

Current parts prices and exchange charges can be determined by contacting the Customer Support Department.

## 4.2.3 Ordering Information

Replacement parts and assemblies are available. Please follow these guidelines when ordering replacement items for the product:

1. Include the Model and Serial Number of the product.
2. Include the Part Number exactly as it appears in the Parts List under the column, "Part Number."
3. Include a description of the item.

**EXAMPLE ORDERS:**

(1) ea. P/N 0334-00-2611-01
Label, Fuse Replacement, Serial No. XXXX
(2) ea. P/N 0213-07-0404
Screw, Self Tap, #4 x 0.25", Serial No. XXXX

**NOTE:** **Mindray DS USA, Inc. maintains a policy of continuous development for product improvement and reserves the right to change materials, specifications, and prices without notice.**

# 4.3 Isometric Drawings

## 4.3.1 Chassis

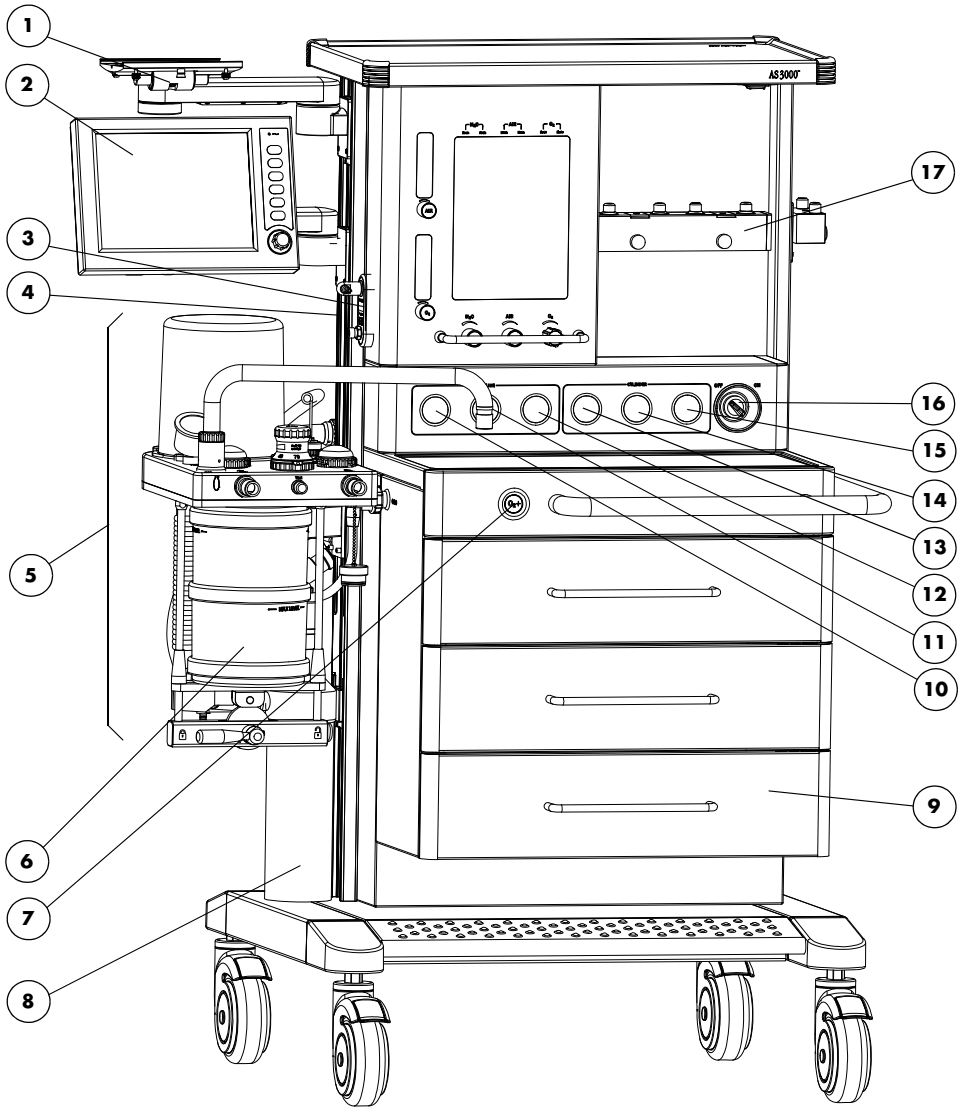


**FIGURE 4-1 AS3000** Frontview

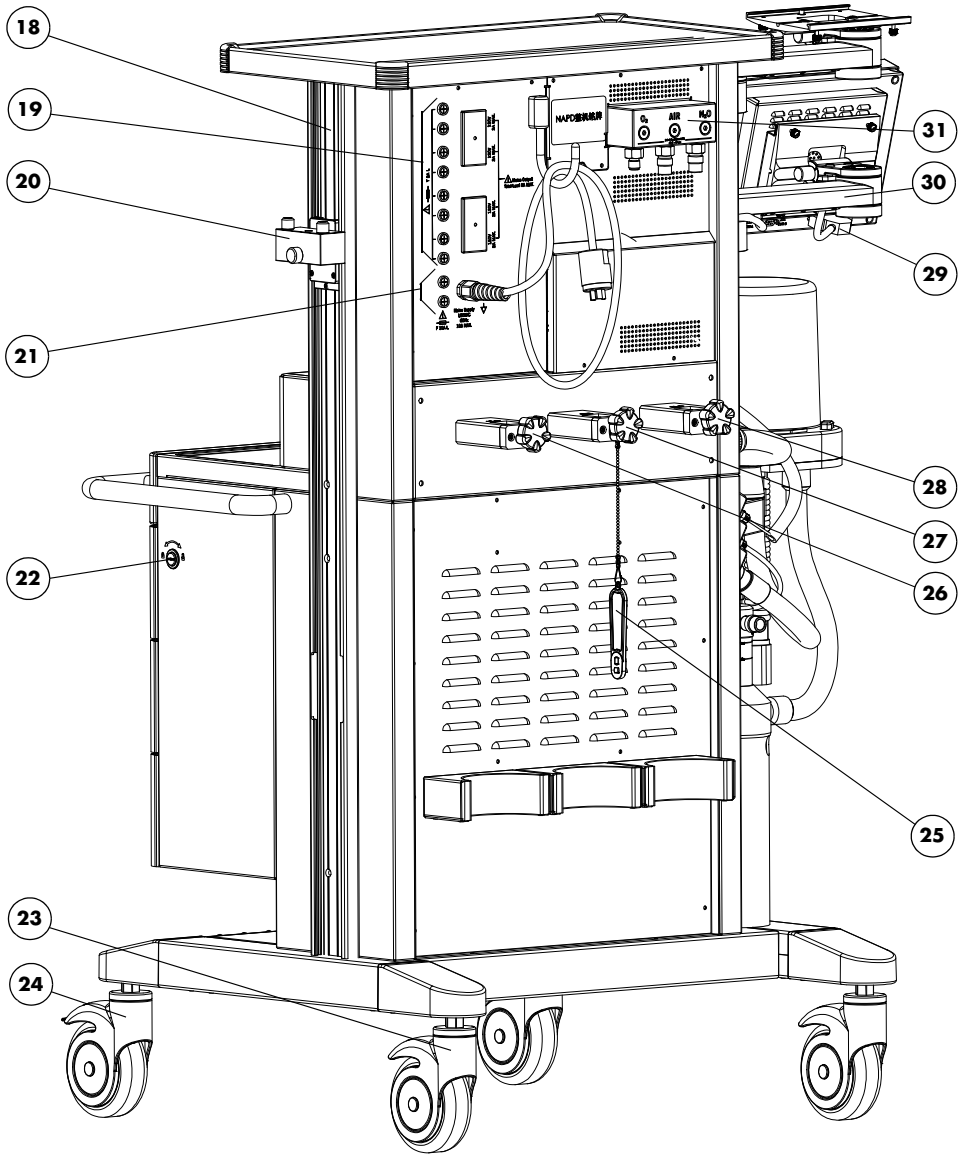


**FIGURE 4-2 AS3000** Rearview

### 4.3.1.1 Chassis Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 1 | Arm, Monitor | 0436-00-0248 |
| 2 | User Interface Assembly | 0997-00-0620 (M31)<br>021-000026-00 (M32)<br>115-005982-00 (M33) |
| 3 | Aux Gas Assembly | 0997-00-0634 |
| 4 | Channel, Left Side | 0436-00-0250 |
| 5 | Breathing System | 115-005967-00 |
| 6 | Absorber Canister Assembly | 0997-00-0629 (original)<br>115-005724-00 (revised) |
| 7 | $O_2$ Flush Valve Assembly | 0104-00-0064 |
| 8 | Scavenger System, AS3000 | 0992-00-0279 |
| 9 | Drawer Assembly | 0441-00-0206 |
| 10 | Gauge, $N_2O$, Line Pressure | 0118-00-0039 |
| 11 | Gauge, AIR, Line Pressure | 0118-00-0040 |
| 12 | Gauge, $O_2$, Line Pressure | 0118-00-0041 |
| 13 | Gauge, $N_2O$ High Pressure | 0118-00-0042 |
| 14 | Gauge, AIR High Pressure | 0118-00-0036 |
| 15 | Gauge, $O_2$ High Pressure | 0118-00-0037 |
| 16 | Switch, Mains (external)<br>Switch, Mains (internal) | 0261-00-0220<br>0261-00-0218 |
| 17 | Vaporizer Mount | 0997-00-0616 |
| 18 | Rail, Right Side | 0436-00-0251 |
| 19 | Fuse, 2A, 250V | 0159-00-0057 |
| 20 | Vaporizer Storage Mount | 0436-00-0221 |
| 21 | Fuse, 10A, 250V | 0159-00-0058 |
| 22 | Lock, Key | 0366-60-0137 |
| 23 | Caster, without Brake | 0401-00-0054 |
| 24 | Caster, with Brake | 0401-00-0053 |
| 25 | Tank Wrench Assembly | 0367-00-0080 |
| 26 | Yoke, $O_2$ | 0103-00-0676 |
| 27 | Yoke, AIR | 0103-00-0677 |
| 28 | Yoke, $N_2O$ | 0103-00-0678 |
| 29 | User Interface Cable | 0012-00-1778 |
| 30 | User Interface Mounting Arm | 0436-00-0249 |
| 31 | Gas Input Assembly | 115-006314-00 |
| NS | Kit Check Valve | 0040-00-0458 |

*NS Not Shown*

## 4.3.2 Breathing System

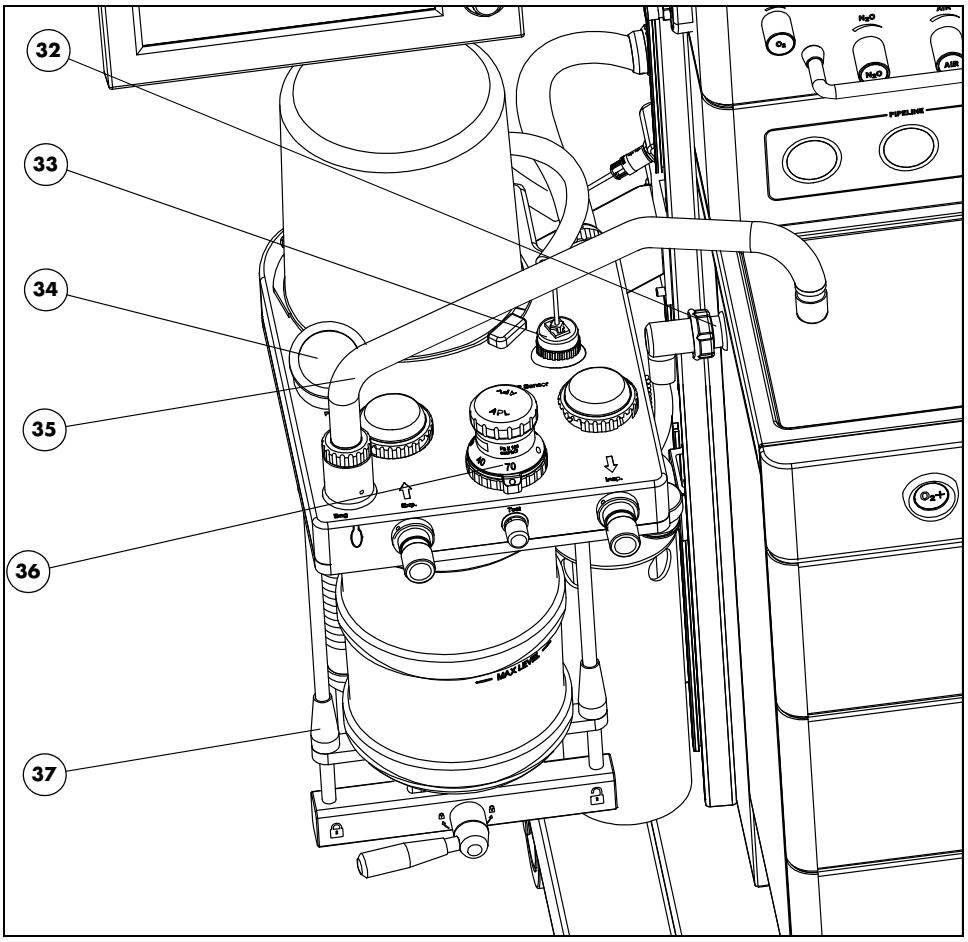


**FIGURE 4-3** Breathing System, Top View

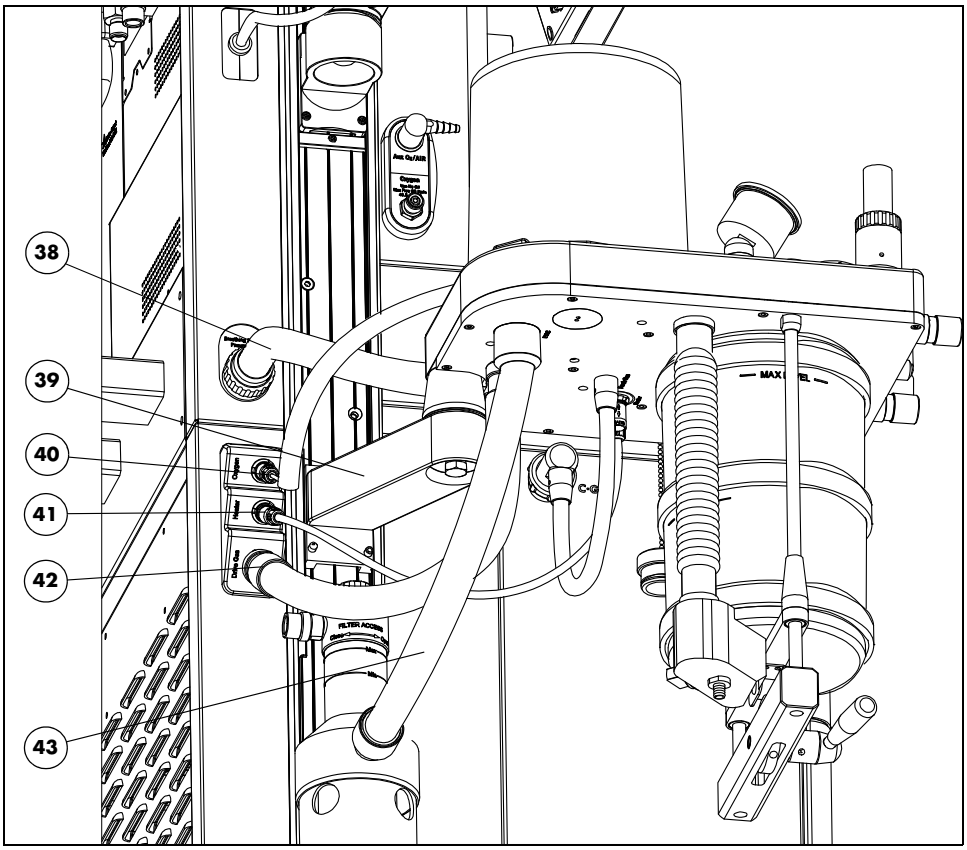


**FIGURE 4-4** Breathing System Bottom View

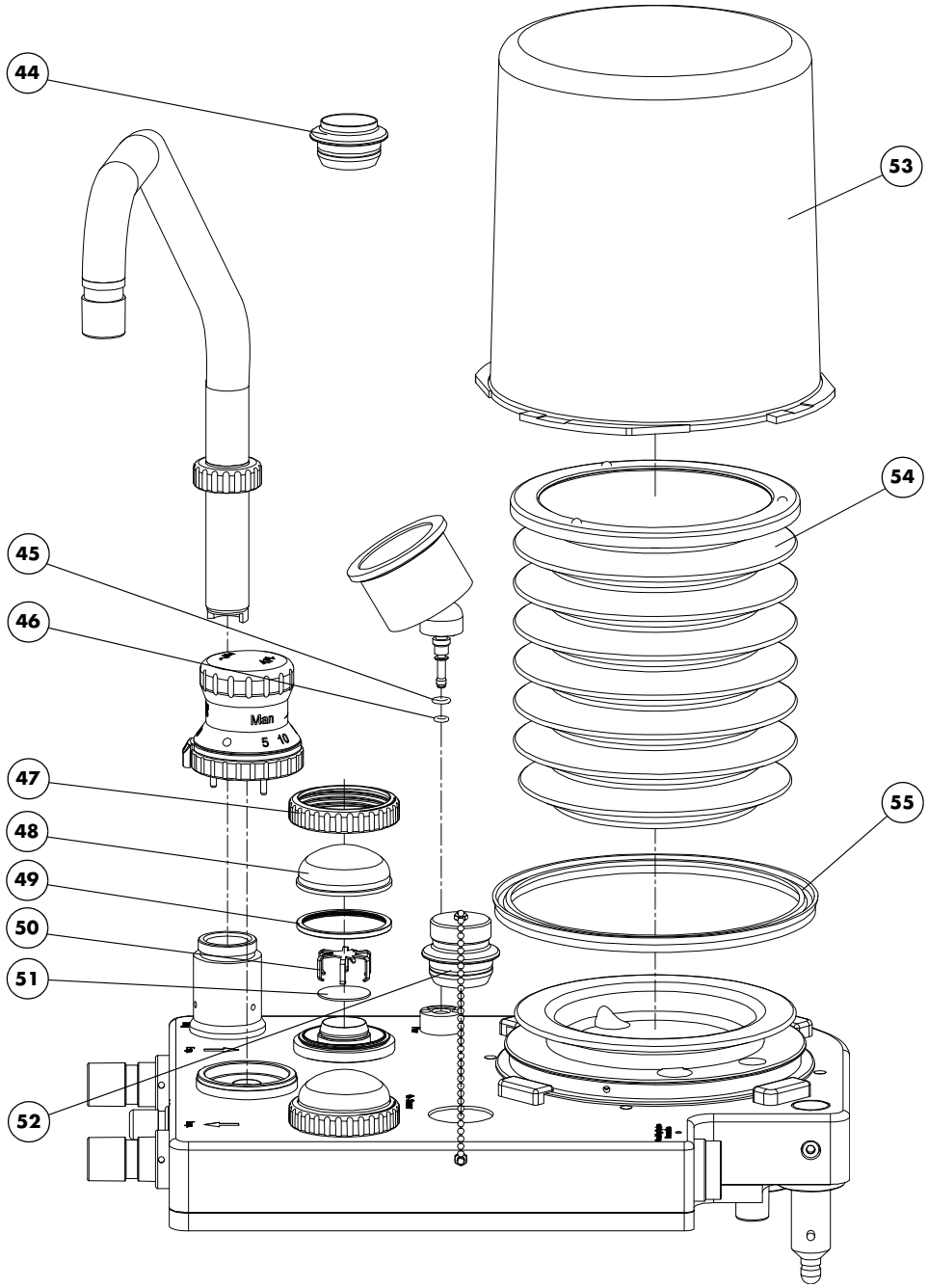


**FIGURE 4-5** Breathing System Exploded Top View

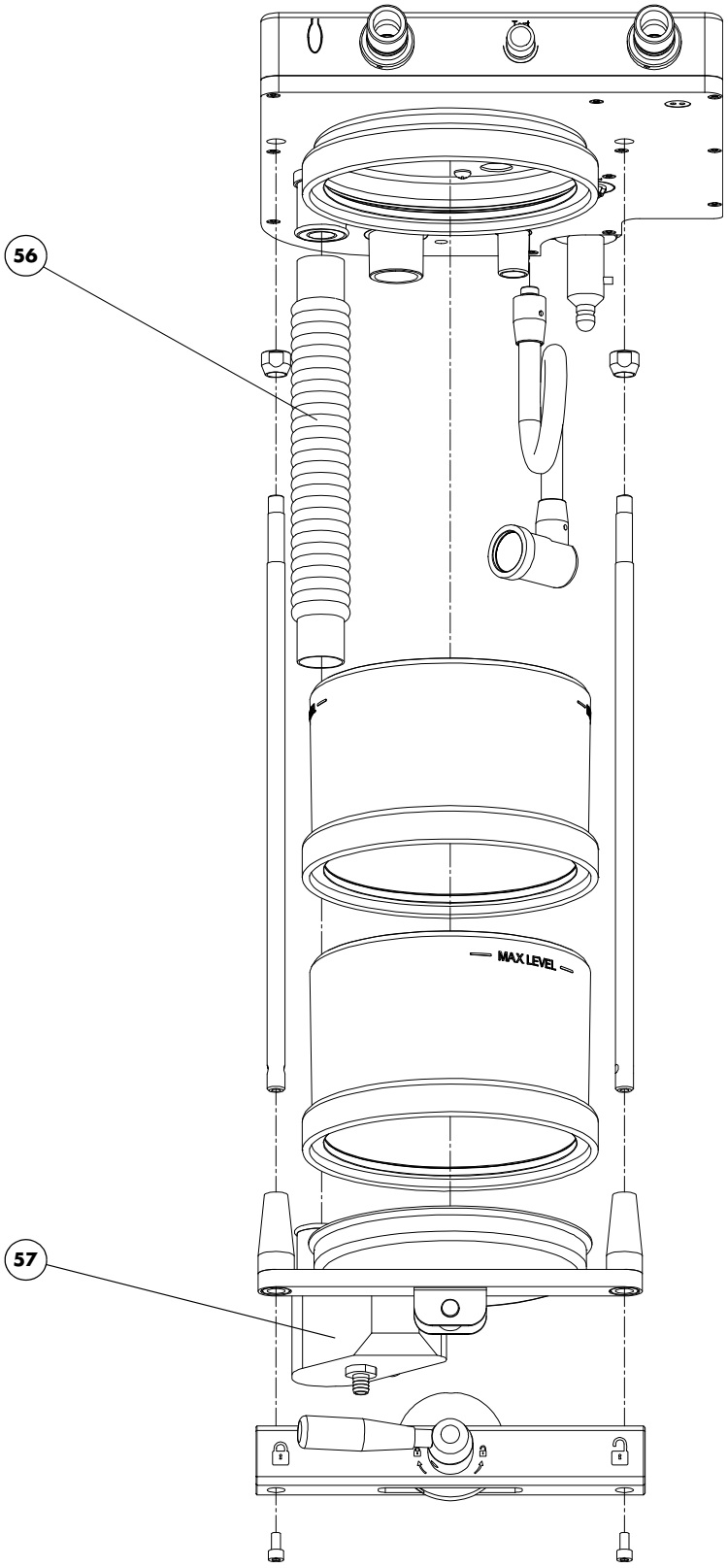


**FIGURE 4-6** Breathing System Exploded Bottom View

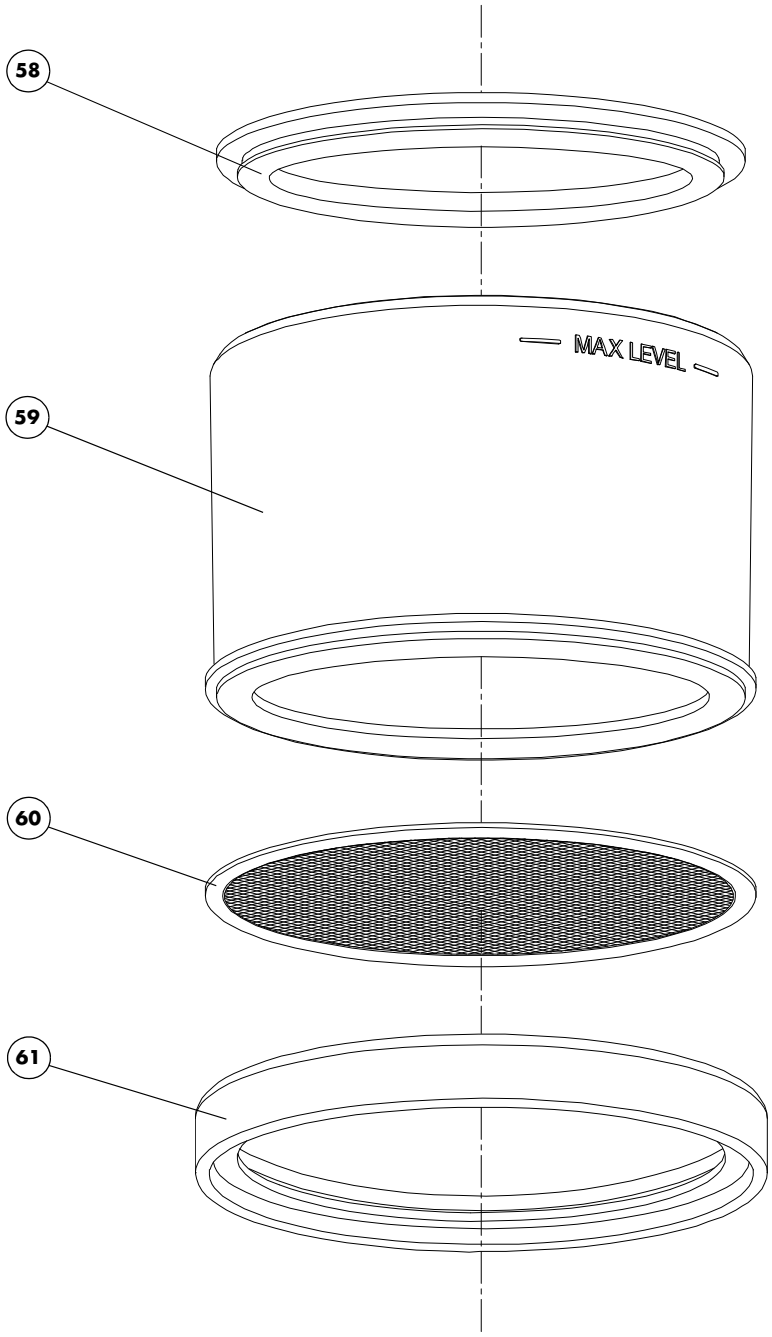


**FIGURE 4-7** Absorber Canister Exploded View

## 4.3.2.1 Breathing System Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 32 | Common Gas Outlet Assembly | 0997-00-0633 |
| 33 | $O_2$ Sensor | 0600-00-0149 |
| 34 | Airway Pressure Gauge | 0118-00-0038 |
| 35 | Bag Arm Tall | 0009-00-0013 |
| 36 | APL Valve | 0104-00-0065 |
| 37 | Absorber Canister Assembly | 0997-00-0629 (original)<br>115-005724-00 (revised) |
| 38 | Breathing System Pneumatics Hose | 082-000387-00 |
| 39 | Breathing System Support Arm | 0436-00-0253 |
| 40 | $O_2$ Sensor cable | 0012-00-1775 |
| 41 | Cable, Heater | 0012-00-1780 |
| 42 | Drive Gas Hose | 0004-00-0098 |
| 43 | AGSS Transfer Hose | 0004-00-0095 |
| 44 | $O_2$ Sensor Interface | 0198-00-0080 |
| 45 | O Ring, 6 x 1.8 | 0354-00-0188 |
| 46 | O Ring, 4 x 1.8 | 0354-00-0189 |
| 47 | Ring, I/E Valve | 0219-00-0018 (plastic)*<br>0219-00-0020 (metal)* |
| 48 | Cover, I/E Valves | 0352-00-0068 |
| 49 | Gasket, I/E Valves | 0354-00-0192 |
| 50 | Frame, I/E Valve | 0352-00-0069 |
| 51 | Disc, Ceramic I/E Valve | 0354-00-0182 |
| 52 | $O_2$ Port Plug | 0198-00-0083 |
| 53 | Cover, Bellows | 0198-00-0079 |
| 54 | Bellows Assembly | 115-005968-00 |
| 55 | Gasket, Bellows Canister base | 0354-00-0191 |
| 56 | Absorber Hose | 0004-00-0097 |
| 57 | Absorber Mount Assembly | 0436-00-0256 |
| 58 | Absorber Gasket | 0354-00-0199 (original)<br>047-002849-00 (revised) |
| 59 | Canister, Soda Lime | 0352-00-0070 (original)<br>045-000254-00 (revised) |
| 60 | Absorber Screen, Metal | 0378-00-0073 |
| 61 | Absorber Canister Gasket | 0354-00-0183 (original)<br>045-000252-00 (revised)<br>047-002850-00 (revised) |
| NS | Bag Arm Short | 0009-00-0012 |
| NS | Bellows Support Cage | 082-000389-00 |
| NS | Alignment Bracket Kit | 115-007641-00 |

*NS Not Shown*
** Parts are not one-to-one interchangeable.*

## 4.3.3 Electric Box

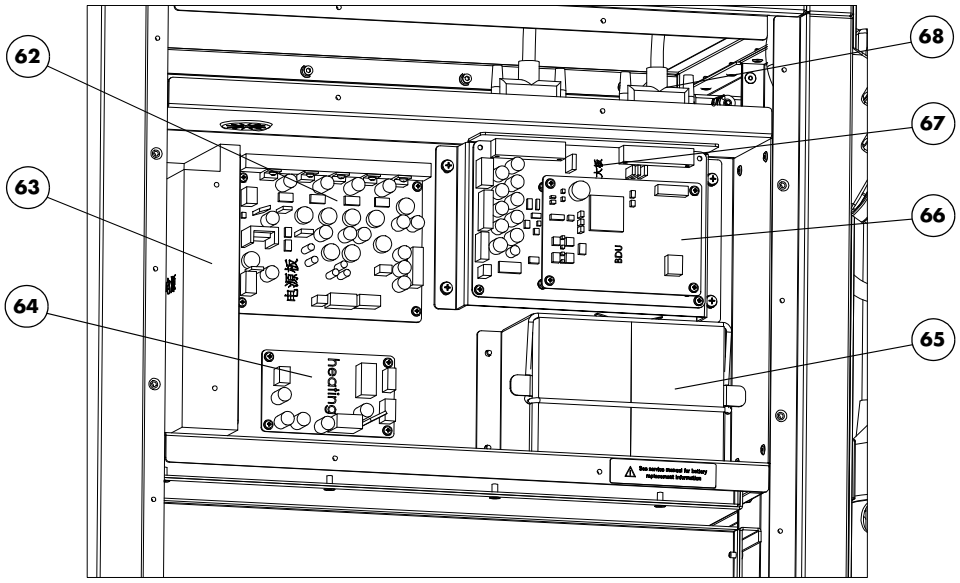


**FIGURE 4-8** Electric Box Assembly

### 4.3.3.1 Electric Box Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 62 | PC Board Assembly, Power | 0671-00-0264 (M31)<br>051-000484-00 (M32)<br>051-000484-00 (M33) |
| 63 | Power Supply, SNP-B209, Switching | 0014-00-0091 |
| 64 | PC Board Assembly, Breathing System Heater | 0671-00-0107 |
| 65 | Cable, Amp PC Board to Sensor PC Board | 0012-00-1777 |
| 66 | PC Board Assembly, Amplifier | 0671-00-0263 |
| 67 | PC Board Assembly, BDU | 0671-00-0262 (M31)<br>051-000517-00 (M32)<br>051-000493–00 (M33) |
| 68 | Battery Assembly SLA-5AH24V-3 | 0997-00-0619 |

## 4.3.4 Gas Circuit Box

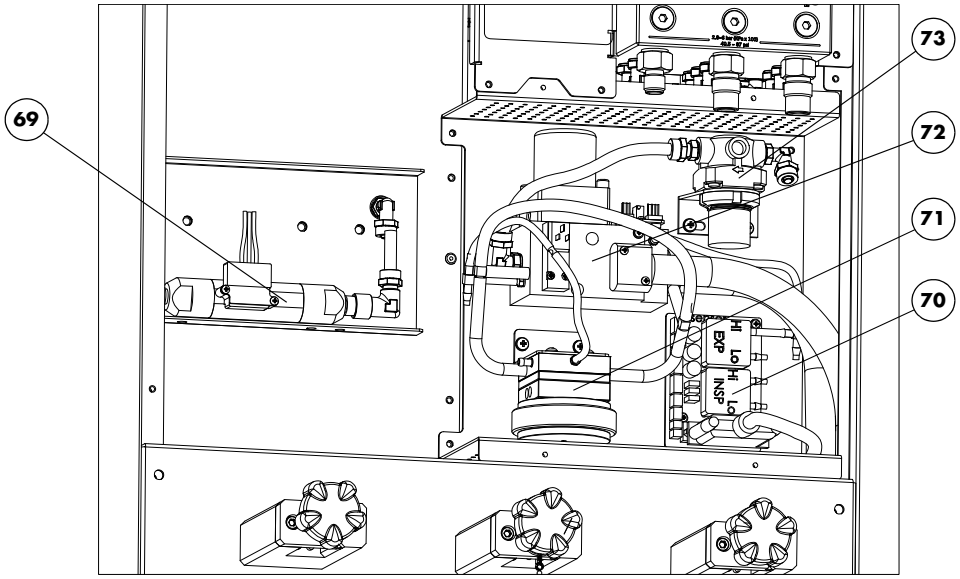


**FIGURE 4-9** Gas Circuit Box Assembly

### 4.3.4.1 Gas Circuit Box Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 69 | Electronic Flow Meter Assembly | 0154-00-0010 |
| 70 | PC Board Assembly, Sensor | 0671-00-0265 |
| 71 | PEEP Valve | 0104-00-0062 |
| 72 | Gas Drive Module Assembly | 0997-00-0632 |
| 73 | Valve, Pressure Reducer | 0103-00-0681 |
| NS | Exhaust Gas Outlet Port | 082-000681-00 |
| NS | Tube, Green, 6 mm OD, 4 mm ID | 0008-00-0338 |
| NS | Tube, Green, 8 mm OD, 6 mm ID | 0008-00-0337 |
| NS | Tube, Yellow, 6 mm OD, 4 mm ID | 0008-00-0356 |
| NS | Tube, Blue, 6 mm OD, 4 mm ID | 0008-00-0340 |
| NS | Tube, Black, 8 mm OD, 6 mm ID | 0008-00-0358-15 |
| NS | Tube, Silicone, 20 mm OD, 15 mm ID | 0008-00-0371 |
| NS | Tube, Silicone, 5 mm OD, 2 mm ID | 0008-00-0370 |
| NS | Tube, Silicone, 8 mm OD, 4 mm ID | 0008-00-0369 |

*NS Not Shown*

## 4.3.5 User Interface

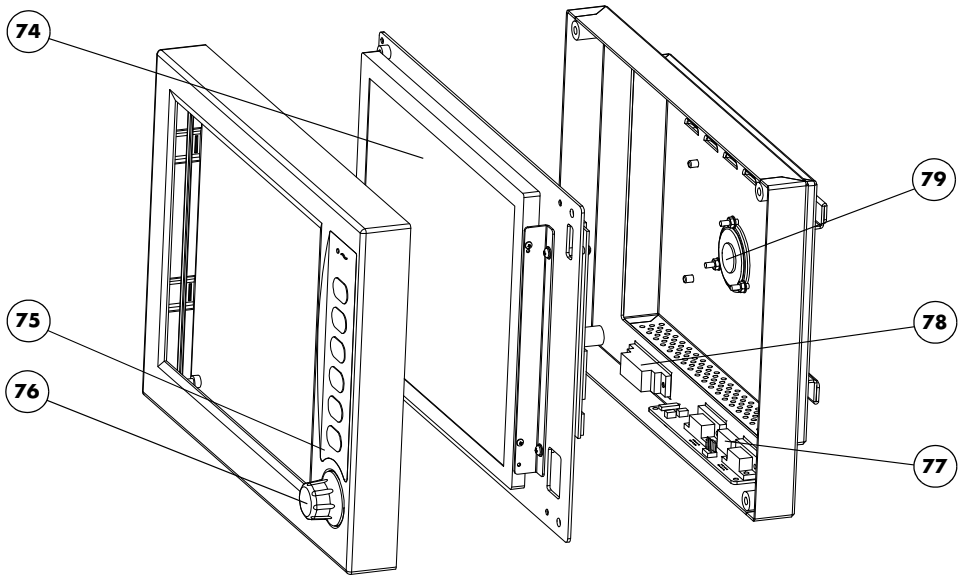


**FIGURE 4-10** User Interface Assembly

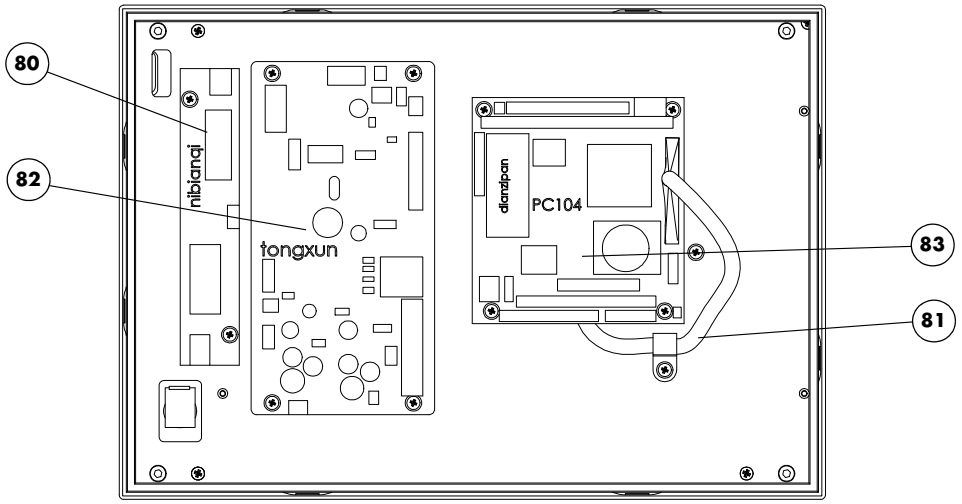


**FIGURE 4-11** User Interface Rearview

### 4.3.5.1 User Interface Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 74 | LCD Display | 0160-00-0119 |
| 75 | Keypad Overlay | 0331-00-0139 |
| 76 | Knob, Navigator™ | 0366-00-0136 |
| 77 | PC Board RS232 | 0671-00-0111 |
| 78 | Cable, Comm PC Board to Display Panel | 0012-00-1774 |
| 79 | Speaker Assembly | 0119-00-0230 |
| 80 | Inverter, LCD | 0671-00-0112 |
| 81 | Cable, PC104 PC Board to Display | 0012-00-1776 |
| 82 | Communications Board | 0671-00-0109 (M31)<br>051-000483-00 (M32, M33) |
| 83 | PC104 Board | 0671-00-0276 (M31)<br>051-000518-00 (M32)<br>050-000359-00 (M33) |
| | PC104 Board (old) | 0671-00-0110 (M31)<br>N/A (M32)<br>051-000564-00 (M33) |
| — | Display Assembly | 0997-00-0620 (M31)<br>021-000026-00 (M32)<br>115-005982-00 (M33) |

## 4.3.6 Flowmeter

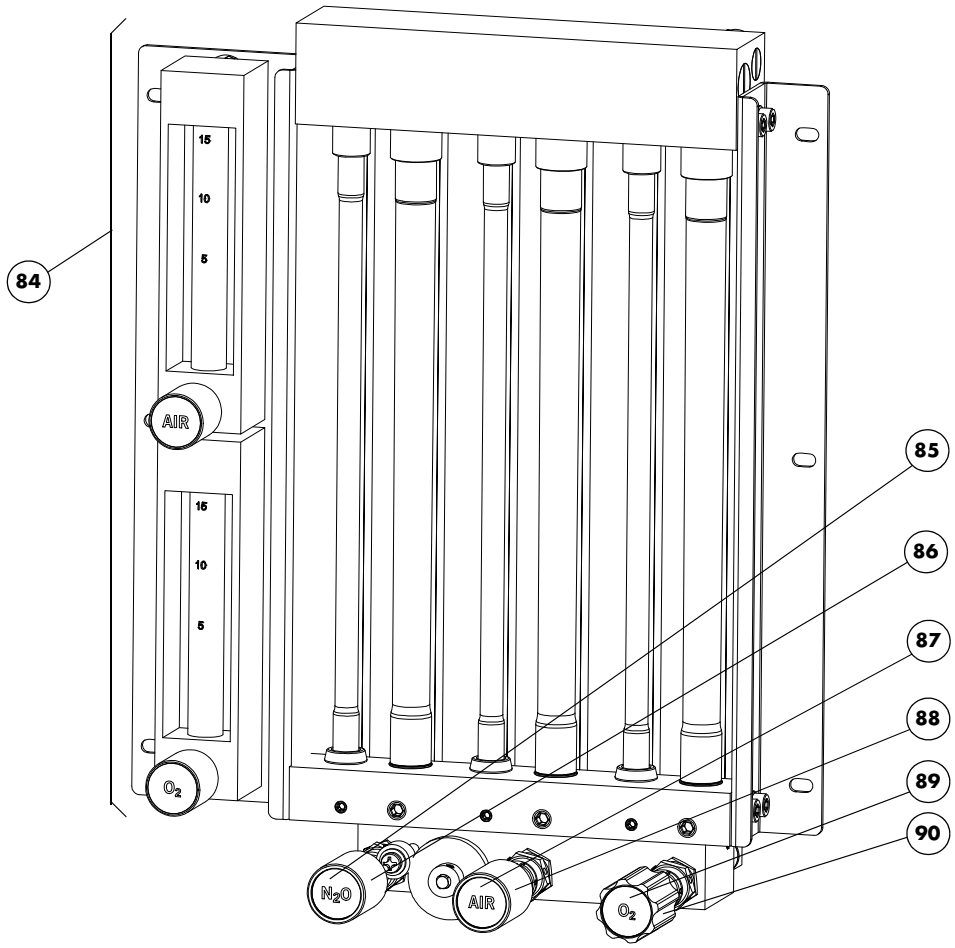


**FIGURE 4-12** Flowmeter Module

## 4.3.6.1 Flowmeter Parts List

| FIG. NO. | DESCRIPTION | PART NUMBER |
|---|---|---|
| 84 | Flow Meter FM400 Assembly | 0997-00-0617 (for -01 units)<br>115-005969-00 (for -02 units) |
| 85 | Label, Flowmeter $N_2O$ | 0334-00-1780 |
| 86 | $N_2O$ Knob | 0366-00-0134 |
| 87 | Label, Flowmeter AIR | 0334-00-1781 |
| 88 | AIR Knob | 0366-00-0133 |
| 89 | Label, Flowmeter $O_2$ | 0334-00-1779 |
| 90 | $O_2$ Knob | 0366-00-0135 |

# 5.0 *Calibration*

## 5.1 Introduction

This section provides detailed information required to properly test and calibrate the **AS3000**. Calibration consists of making mechanical and electrical adjustments with the proper test equipment. The instrument should be tested and calibrated after repairs have been completed or at regular intervals as part of a periodic maintenance procedure.

**NOTE: Both calibration and a functional test must be performed to verify complete and proper operation.**

**NOTE: Calibration is conducted in normal operating mode and in Service Diagnostic mode.**

Ensure that all testing materials, including drive gas, breathing circuits, test fixtures, tools and documents are available and current, calibrated and in good working order prior to beginning.

Testing and programming requires utilizing internal service software. A password is required to enter these screens. This password is provided during biomedical technician training.

# 5.2 Calibration Warnings, Precautions, and Notes

## 5.2.1 Warnings

**WARNING: For continued protection against fire hazard, replace all fuses with the specified type and rating.**

**WARNING: In order to prevent an electric shock, the machine (protection class I) may only be connected to a correctly grounded mains connection (socket outlet with grounding contact).**

**WARNING: Remove all accessory equipment from the shelf before moving the anesthesia machine over bumps or on any inclined surface. Heavy top loading can cause the machine to tip over causing injury.**

**WARNING: Possible explosion hazard. Do not operate machine near flammable anesthetic agents or other flammable substances. Do not use flammable anesthetic agents (i.e., ether or cyclopropane.)**

**WARNING: The use of anti-static or electrically conductive respiration tubes, when utilizing high frequency electric surgery equipment, may cause burns and is therefore not recommended in any application of this machine.**

**WARNING: Possible electric shock hazard. The machine may only be opened by authorized service personnel.**

**WARNING: Compressed gasses are considered Dangerous Goods/ Hazardous Materials per I.A.T.A. and D.O.T. regulations. It is a violation of federal and international law to offer any package or over pack of dangerous goods for transportation without the package being appropriately identified, packed, marked, classified, labeled and documented according to D.O.T. and I.A.T.A. regulations. Please refer to the applicable I.A.T.A. Dangerous Goods Regulations and /or the Code of Federal Regulations 49 (Transportation, Parts 171-180) for further information.**

## 5.2.2 Cautions

**CAUTION: Refer to the "Periodic Maintenance Schedule of Service Activities" on page 6-2, in the Periodic Maintenance section for assistance when performing scheduled periodic maintenance.**

**CAUTION: Do not leave gas cylinder valves open if the pipeline supply is in use and the system master switch is turned to 'ON'. If used simultaneously, cylinder supplies could be depleted, leaving an insufficient reserve supply in the event of pipeline failure.**

**CAUTION: Use cleaning agent sparingly. Excess fluid could enter the machine, causing damage.**

**CAUTION: This machine must only be operated by trained, skilled medical staff.**

### 5.2.3 Notes

**NOTE:** **Only bacterial filters with a low flow resistance must be connected to the patient module and/or the patient connection.**

**NOTE:** **Use surgical gloves whenever touching or disassembling valves or other internal components of the Breathing System.**

**NOTE:** **Ensure that the gas supply of the machine always complies with the technical specification.**

**NOTE:** **The APL Valve and PAW gauge numerics are for reference only. Calibrated patient airway pressure is available on the ventilator screen.**

**NOTE:** **If the machine should show faults during the initial calibration or testing, the machine should not be operated until the fault has been repaired by a qualified service technician.**

**NOTE:** **After servicing, functional, sensor and system tests must be carried out before clinical use.**

**NOTE:** **To accommodate additional monitors and other equipment the AS3000 offers up to two vertical mounting tracks. Use of unauthorized mounting accessories is not recommended.**

**NOTE:** **Always secure any equipment placed on the AS3000's top shelf.**

# 5.3 General Guidelines

1. Before disconnecting any pneumatic hoses, the hoses and mating fittings should be tagged to show the proper connections. When reconnecting, all hoses must be checked for proper connection. To further assure proper connection, all pneumatic calibrations and tests defined in this manual should be accomplished before use on a patient.
2. Once the instrument covers have been removed, an electric shock hazard may exist. Therefore, calibration should only be performed by qualified service personnel who proceed with care and follow proper servicing techniques.
3. Do not attempt to calibrate the instrument without the test equipment and tools listed in this manual.
4. Exercise care when reaching into the opened instrument which contains line (mains) voltage.
5. When making adjustments and measurements, avoid accidental shorting of component leads that can result in component failure.
6. Perform all steps in the order given. Do not skip any steps unless noted.
7. Understand each step of the procedure thoroughly before performing the procedure.
8. Before removing or replacing any circuit boards, disconnect the **AS3000** from line power, switch the Mains Switch to the OFF position, and disconnect the negative terminal from the battery.

# 5.4 Test Equipment and Special Tools Required

See "Special Tools Required" on page 3-3, for a list of tools required for calibration.

# 5.5 Calibration Procedures

**NOTE: The following calibration procedures must be performed in sequence.**

## 5.5.1 Oxygen Sensor Calibration

**NOTE: See "Periodic Maintenance Schedule of Service Activities" on page 6-2 for when to calibrate the oxygen sensor.**

**1. Preparing the unit**

- **a.** Allow the breathing system to warm up and reach thermal equilibrium (approximately 30-60 minutes).
- **b.** In Standby mode, press the **MENU** button. The menu screen will appear.
- **c.** Select **Service**, then input the password **2010** to enter the Service screen.
- **d.** Select **Calibration** to enter the Calibration screen.
- **e.** Select **Oxygen Sensor** to enter the Oxygen Sensor Calibration screen.

**2. Calibration**

**NOTE: Do not shake the $O_2$ sensor during calibration.**

**NOTE: During calibration, keep the $O_2$ sensor in a vertical position, connector side up, and bottom side exposed to room air; keep the $O_2$ sensor near the heated block to minimize the temperature difference from within the heated block.**

**NOTE:** **If the system is going to be used during the calibration, insert the $O_2$ cell plug into the port from which the oxygen sensor was removed using a push and turn motion.**

**a.** Select **21%** to enter the 21% oxygen concentration calibration screen.

**b.** Remove the oxygen sensor from the Breathing System and expose it to room air for at least 3 minutes.

**c.** Flush the $O_2$ sensor with air from the auxiliary output for 5-10 seconds to ensure that no $O_2$ bubbles are trapped in the sensor.

**d.** Select **Next** to start 21% oxygen concentration calibration.

**NOTE:** **The $O_2$ sensor voltage is displayed during the calibration. This is the amplified $O_2$ cell voltage at the A/D converter for the oxygen sensor. The $O_2$ sensor voltage is not displayed for UI versions 2.24 and lower.**

**e.** When calibration is successfully completed, install the oxygen sensor into the Breathing System.

**NOTE:** **The oxygen sensor must be installed in the Breathing System for 10 minutes prior to 100% oxygen concentration calibration to adjust to the temperature of the system.**

**f.** Press the $O_2$ Flush button for 5-10 seconds to clear out any non-$O_2$ gases from the system.

**g.** Expose the oxygen sensor to 100% pure oxygen (5 L/min) for at least 3 minutes.

**h.** Select **100%** to enter the 100% oxygen concentration calibration screen.

**i.** Select **Next** to start 100% oxygen concentration calibration.

## 5.5.2 Proportional Valve Regulator Calibration

1. Open the gas cover panel.
2. Remove the drive pressure source from the **AS3000**.
3. Disconnect the input hose from the Proportional Valve.
4. Connect a Digital Pressure Meter to the proportional valve input hose.
5. Reconnect the drive pressure source to the **AS3000**.
6. Set the pressure on the pressure regulator to between 25.1 and 25.7 psi by pulling down on the pressure regulator knob and rotating it until the desired pressure is reached. (see FIGURE 5-1)
7. Push the regulator knob back up once the desired pressure is reached to lock it in place.
8. Remove the drive pressure source from the **AS3000**.
9. Remove the Pressure Meter and reconnect the input hose to the Proportional Valve.
10. Reconnect the drive pressure source to the **AS3000**.

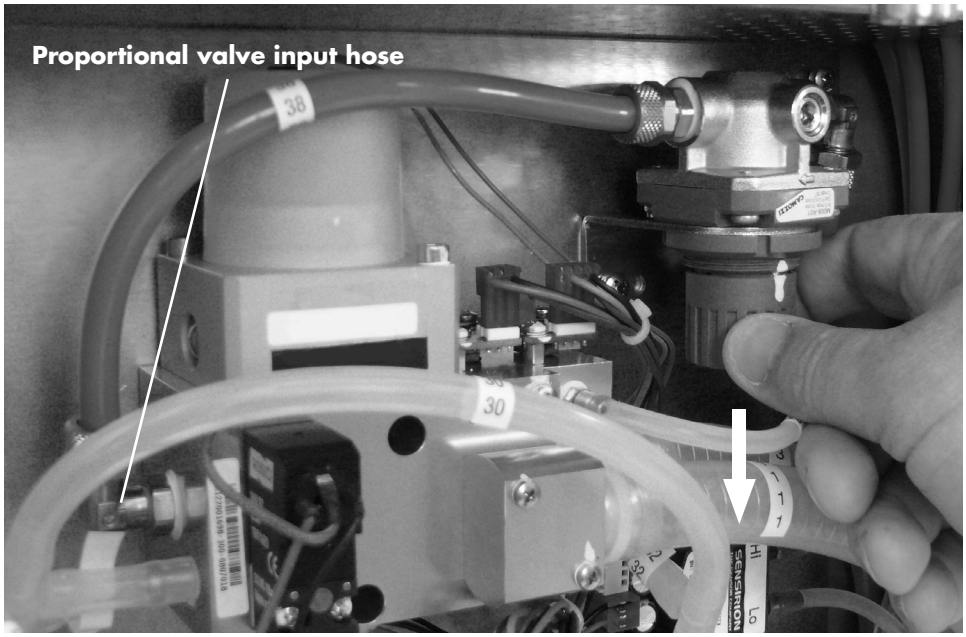


**FIGURE 5-1** The Proportional Valve Regulator

## 5.5.3 Flow Sensor Calibration

**1. Preparing the unit**

**FIGURE 5-2** Connecting the Respiration Tube

**FIGURE 5-3** Blocking the Bag Port

**a.** Remove the Inspiratory and Expiratory valve disks, and reinstall the valve covers.

**b.** Connect a Respiration Tube between the Inspiratory and Expiratory Ports. (see FIGURE 5-2)

**c.** Use the **AS3000** Test Plug to block the Bag Port. (see FIGURE 5-3)

**d.** Set the APL Valve to **70** $cmH_2O$.

**e.** With the Fresh Gas flow set to 100 mL/min, press the $O_2$ Flush button. Verify that the Paw gauge reads a minimum of 40 $cmH_2O$ after releasing the button.

**f.** If 40 $cmH_2O$ cannot be attained, open and close the APL Valve and repeat step **e** prior to leakage troubleshooting.

**g.** Set the Fresh Gas flow to 0 mL/min.

**h.** Select **Continue**.

## 2. Calibration

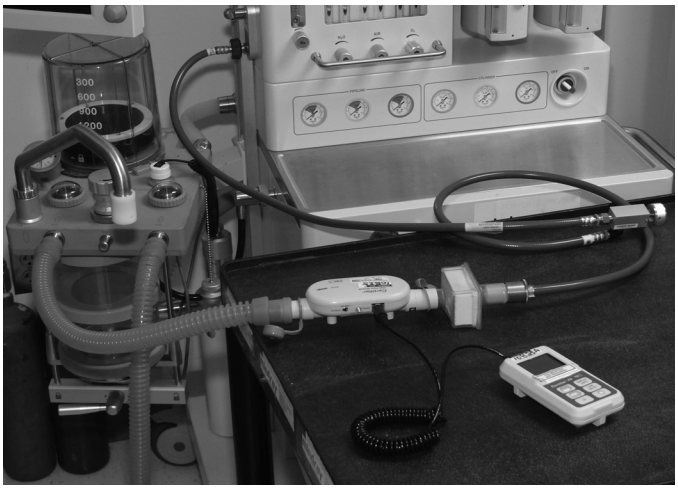

**FIGURE 5-4** Connecting the Vent Tester to the **AS3000**

**a.** Connect one end of the Calibration Hose to the High Pressure port on the **AS3000** and the other to the inlet on the Vent Tester.

**b.** Connect one end of the Respiration Tube to the expiratory port on the **AS3000** and the other to the outlet of the Vent Tester.

**c.** Connect an unterminated tube (at least 1 meter long) to the inspiratory port on the **AS3000**.

**d.** Select **Continue** to start calibration.

**e.** Ensure that there is 0 flow on the Flow Analyzer.

**f.** Set the on screen calibration to **0**, and select **Done** to begin calibration. Successful calibration will be confirmed by illuminating the corresponding calibration value yellow. If the calibration value illuminates red, recalibrate the value until it successfully calibrated.

**g.** Set the onscreen calibration value to **1**.

**h.** Raise the flow until it reads 1.00 on the Flow Analyzer using the calibration hose valve.

**i.** Select **Done** to begin calibration.

**j.** Repeat steps **g.** through **i.** for all calibration values listed on the screen. Ensure all successfully calibrate and illuminate yellow.

**k.** After all values are successfully calibrated select **Finish Cal**.

**l.** The **AS3000** will confirm that calibration was successfully completed.

**m.** Select **Done** to return to the calibration screen.

**NOTE: The flow should not be fluctuating in during the calibration.**

## 5.5.4 Flow Valve Calibration

**1. Preparing the unit**

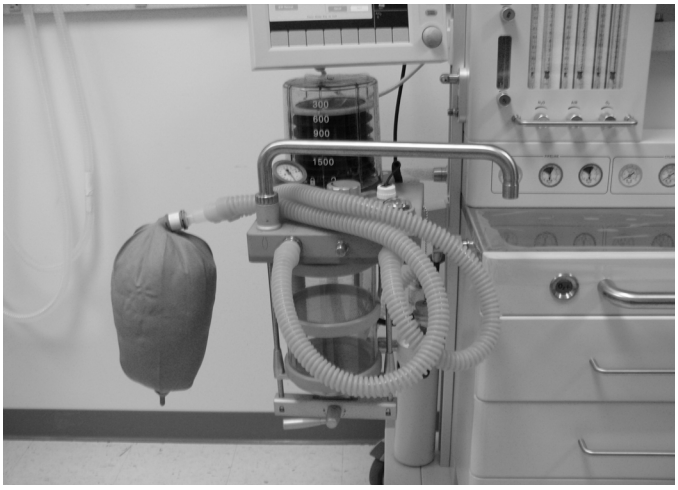

**FIGURE 5-5** Connecting the breathing circuit

**a.** Reinstall the Inspiratory and Expiratory valve disks.

**b.** Connect a breathing circuit to the Breathing System (see FIGURE 5-5).

**c.** Connect a 3L bag to the Y-fitting.

**NOTE:** **A 2.3L bag can be used in place of a 3L bag.**

**d.** Select **Continue.**

**2. Calibration**

**a.** Press the $O_2$ Flush Valve to fully fill bellows.

**b.** Select **Continue** to start calibration.

**c.** Follow the on-screen instructions.

**NOTE:** **The flow Valve calibration duration is approximately 5 minutes.**

## 5.5.5 Paw Sensor

### 1. 0 cm$H_2O$ Calibration

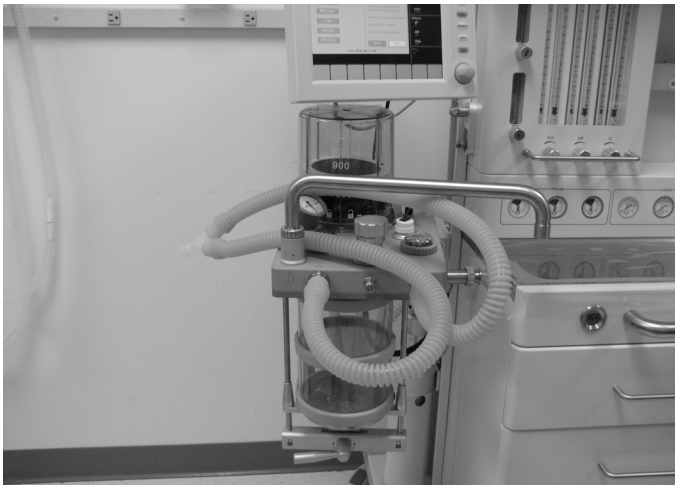

**FIGURE 5-6** Removing the 3L bag

**a.** Remove the 3L bag from the breathing circuit.

**b.** Set the APL Valve to **0** cm$H_2O$.

**c.** Select **Continue** to start calibration.

**d.** Follow the on-screen instructions.

**2. 30 cm$H_2O$ Calibration**

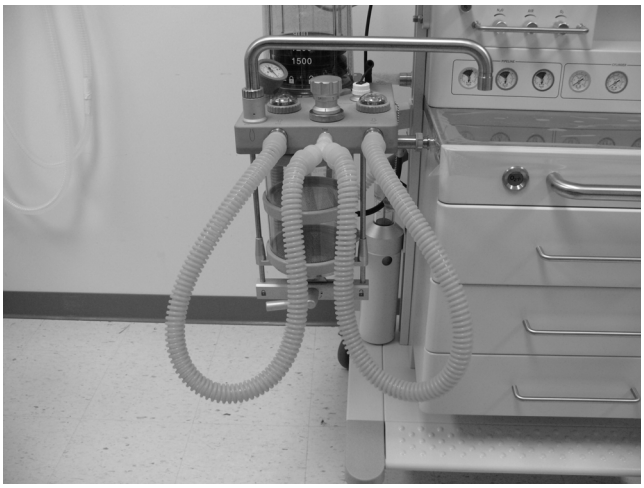

**FIGURE 5-7** Connecting the Y-fitting to the Test Port

**a.** Set the APL Valve to **30** cm$H_2O$.

**b.** Connect the Y-fitting to the Test Port (see FIGURE 5-7)

**c.** Connect a Pressure Meter between the Y-fitting and the **AS3000** (use an adapter if necessary).

**d.** Use the $O_2$ Flush Valve and $O_2$ Flow Meter to maintain pressure at 30.0 ±0.2 cm$H_2O$ on the Pressure Meter.

**e.** Select **Continue** to start calibration.

**f.** Follow the on-screen instructions.

## 5.5.6 PEEP Valve

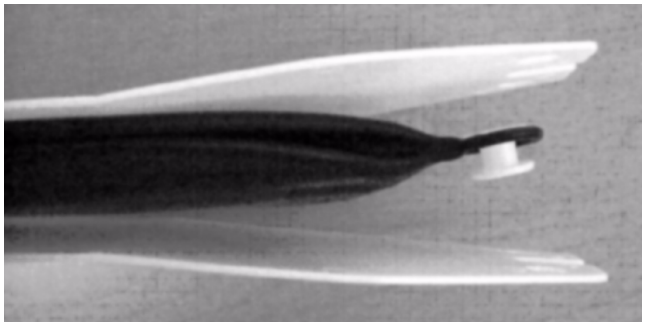

**FIGURE 5-8** Disconnect the plastic flaps from the Adult Test Lung

**1. Calibration**

**a.** Disconnect the plastic flaps from the Adult Test Lung (P/N 0138-00-0012) and connect it to the Y-fitting.

**b.** Set the Fresh Gas flow to 0 mL/min.

**c.** Press the O2 Flush Valve to fully fill bellows.

**d.** Select **Continue** to start calibration.

**e.** Follow the on-screen instructions.

## 5.5.7 Flow Meter

### 1. Calibration

**FIGURE 5-9** Connecting the Flow Analyzer

**a.** Connect one end of the Respiration Tube to the Common Gas Outlet on the **AS3000**, and the other to the inlet on the Flow Analyzer (Certifier-FA PLUS).

**b.** Set the Fresh Gas flow to 0 mL/min.

**c.** Select **Continue** to start calibration.

**d.** Ensure that there is 0 flow on the Flow Analyzer.

**e.** Set the on screen calibration to **0**, and select **Done** to begin calibration. Successful calibration will be confirmed by illuminating the corresponding calibration value yellow. If the calibration value illuminates red, recalibrate the value until it successfully calibrated.

**f.** Set the onscreen calibration value to **1**.

**g.** Raise the flow until it reads 1.00 on the Flow Analyzer using the Flow Meter.

**h.** Select **Done** to begin calibration.

**i.** Repeat steps **f.** through **h.** for all calibration values listed on the screen. Ensure all successfully calibrate and illuminate yellow.

**j.** After all values are successfully calibrated select **Finish Cal**.

**k.** The **AS3000** will confirm that calibration was successfully completed.

**l.** Select **Done** to return to the calibration screen.

**NOTE:** **When calibrating the Flow Meter, use AIR if available, otherwise use a combination of $O_2$ and $N_2O$ to attain a flow of 15 L/min.**

## 5.5.8 Leakage detection

### 5.5.8.1 Startup leakage detection

After restarting, select **Continue** to enter the Leakage Detection screen. Connect the Y-fitting to the **AS3000**'s Test Port, and use the **AS3000** Test Plug to block the Bag Port. Adjust the APL Valve to **30** $cmH_2O$ and close the Flowmeter. Then, select **Continue** to prompt to the next screen.

### 5.5.8.2 APL Valve leakage detection

Follow the on-screen instructions and use the $O_2$ flush valve to pressurize the system. Ensure that the bellows does not move while pressurizing the system. Meanwhile, observe the pressure gauge to ensure that the pressure exceeds 30 $cmH_2O$. Release the $O_2$ Flush Valve and observe whether the pressure displayed on pressure gauge stays within 25 - 35 $cmH_2O$. After passing the test, select **Continue** to prompt to the next screen.

### 5.5.8.3 Safety Valve leakage detection

The Safety Valve leak detection test will start automatically. After finishing, the result of the test will be displayed on the screen. After passing the test, select **Continue** to prompt to the next screen.

### 5.5.8.4 Breathing System leakage detection

Use the $O_2$ Flush Valve to fill the bellow full with oxygen according to the prompt on the screen. Select **Continue** to start the test. After finishing, the results of the test will be displayed on screen. Leakage detection must be less than 400 mL/min. After passing the test, select **Continue** to prompt to the next screen.

## 5.5.9 Compliance detection

Adjust the $O_2$ Flowmeter to make the flow equal to 5 ±0.1 L/min according to the prompt on the screen. Select **Continue** to start the Compliance Detection test. After finishing, the results of the test will be displayed on screen. Compliance detection must be within 1 - 11mL/ $cmH_2O$. After finishing compliance detection successfully, select **Continue** to enter Standby Screen.

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# 6.0 *Periodic Maintenance*

## 6.1 Maintenance Schedule

The following is a list of activities required for periodic maintenance of the **AS3000** Anesthesia System. Physical inspection, replacement of consumables and performance checks should be periodically performed per the schedule listed below. Certain calibration adjustments are required only after replacing one or both of the active devices. The manufacturer is not responsible for component failure or loss resulting from the use of stated consumables beyond their recommended replacement interval. These are noted in the Periodic Maintenance Schedule (See section 6.3).

## 6.2 Periodic Maintenance Consumable Parts Kits

Consumable parts are available in the PM kits listed below.

- AS3000, 12-Month PM Kit: 0040-00-0446
- AS3000, 36-Month PM Kit: 0040-00-0445

Parts must be replaced at periodic intervals according to the schedule.

# 6.3 Periodic Maintenance Schedule of Service Activities

| REQUIRED ACTION | AFTER EACH SERVICE | EVERY 12 MONTHS | EVERY 36 MONTHS | ADDITIONAL INFORMATION |
|---|---|---|---|---|
| Check list before surgery | | X | X | |
| Visual Inspection Checklist | | X | X | |
| Replace of Consumable Parts | | X | X | |
| Battery Maintenance and Replacement | | | X | |
| Functional Tests | | X | X | |
| Preoperative Checklist | X | X | X | |
| $O_2$ Sensor Calibration: 21% | X | | | User to calibrate every 3 days. Service to calibrate after initial installation, and after replacing the $O_2$ sensor. |
| $O_2$ Sensor Calibration: 100% | X | | | Service to calibrate after initial installation, and after replacing the $O_2$ sensor. |

# 6.4 Visual Inspection Checklist

1. Verify that the **AS3000** has no physical damage that would prevent operation.
2. Verify that the breathing circuit and $CO_2$ absorbent are present.
3. Verify that the vaporizers are filled but not overfilled.
4. Verify that the Preoperative Checkout List is attached.
5. Verify that the tank wrench is attached. (0367-00-0080)
6. Verify that the waste gas scavenger hose to the APL Valve (0004-00-0095) is not damaged. Drain any moisture.
7. Verify that the $O_2$, $N_2O$, AIR, VAC and EVAC Supply Hoses (as applicable) are not damaged.
8. Verify that the AC line cord is not frayed or damaged.

# 6.5 Replacement of Consumable Parts

Parts are replaced at multiple intervals from the date of installation.

| | CONSUMABLE PARTS | AMOUNT | 12 MONTH PM | 36 MONTH PM | PART NUMBER |
|---|---|---|---|---|---|
| 1 | $O_2$ Sensor | 1 | check | check | 0600-00-0149 |
| 2 | Battery Assembly SLA-5AH24V | 1 | check | replace | 0997-00-0619 |
| 3 | Drive Gas Tube | 1 | check | replace | 0004-00-0098 |
| 4 | Bellows Assembly | 1 | replace | replace | 115-005968-00 |
| 5 | Scavenger Hose | 1 | check | replace | 0004-00-0095 |
| 6 | I/E Valve gasket | 2 | replace | replace | 0354-00-0192 |
| 7 | O-ring, 6 x 1.8 (for airway pressure gauge) | 1 | replace | replace | 0354-00-0188 |
| 8 | O-ring, 4 x 1.8 (for airway pressure gauge) | 1 | replace | replace | 0354-00-0189 |
| 9 | Bag Arm retainer ring | 1 | check | check | 0354-00-0039 |
| 10 | Disc, Ceramic I/E Valve | 2 | check | replace | 0354-00-0182 |
| 11 | Gasket, Bellows canister base | 1 | replace | replace | 0354-00-0191 |
| 12 | Absorber canister Seal | 3 | check | replace | 0354-00-0183 (original) |
| | | 1<br>2 | check<br>check | replace<br>replace | 047-002850-00 (revised)<br>047-000252-00 (revised) |
| 13 | O-ring $O_2$ Interface / $O_2$ Plug | 2 | replace | replace | 0354-00-0187 |
| 14 | O-ring Vaporizer mount 14x2.65 | 4 | replace | replace | 0354-00-0193 |
| 15 | Cylinder Washer, Black | 3 | replace | replace | 0348-00-0185 |
| 16 | Absorber assembly | 1 | clean | clean | 0997-00-0629 (original)<br>115-005724-00 (revised) |
| 17 | AGSS filter | 1 | clean | replace | 0378-00-0074 |
| 18 | Absorber Gasket | 2 | clean | replace | 0354-00-0199 (original)<br>047-002849-00 (revised) |
| 19 | Check Valve<br>(Applicable to original model P/N 0997-00-0618 only. See “Check Valve Cleaning” on page 6-4.) | 1 | clean | clean | Non-replaceable |
| 20 | User Interface cable jackscrews and jackposts | 2 | Check for Loctite 243 and apply if necessary. Verify jackscrews are secured tightly. | Check for Loctite 243 and apply if necessary. Verify jackscrews are secured tightly. | Non-replaceable |

# 6.6 Check Valve Cleaning

Check valve cleaning is applicable only the original beathing system model (P/N 0997-00-0618) only. It does not need to be performed on the revised beathing system model (P/N 115-005967-00) (see FIGURE 6-1).

Constant contact with moist patient gas can result in the breathing system check valve becoming sticky. Cleaning the check valve will resolve this issue. Perform this cleaning procedure at least every 12 months.

**NOTE: Plastic gloves should be worn when handling breathing systems**

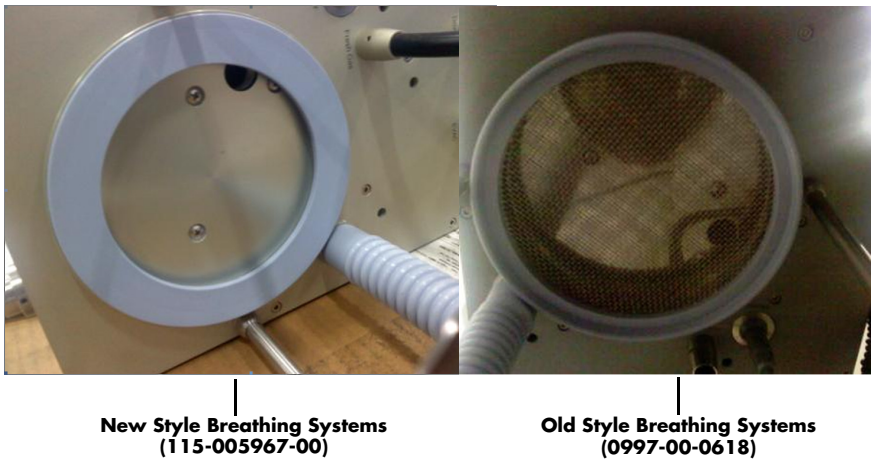


**FIGURE 6-1** Breathing System Styles

## 6.6.1 Tools and Materials

- Philips screw driver
- 2.5 mm hex wrench
- 3 mm hex wrench
- 4 mm hex wrench
- 12 mm standard socket
- 13 mm open end wrench
- Silicone Lubricant (PN 0510-00-0021)
- Tape measure (metric)
- Loctite 243
- Isopropyl alcohol

## 6.6.2 Cleaning Procedure

**1. Remove Absorber Locking Mechanism and Absorber Mount Assembly:**

**1.** Rotate the cam handle to the unlocked position.

**2.** Remove (2) Absorber Canister Assemblies.

**3.** Remove Absorber Hose from port on Absorber Mount Assembly.

**4.** Remove (2) 4mm hex screws securing the Absorber Locking Mechanism to the rods.

**5.** Remove the Absorber Locking Mechanism and Absorber Mount Assembly.

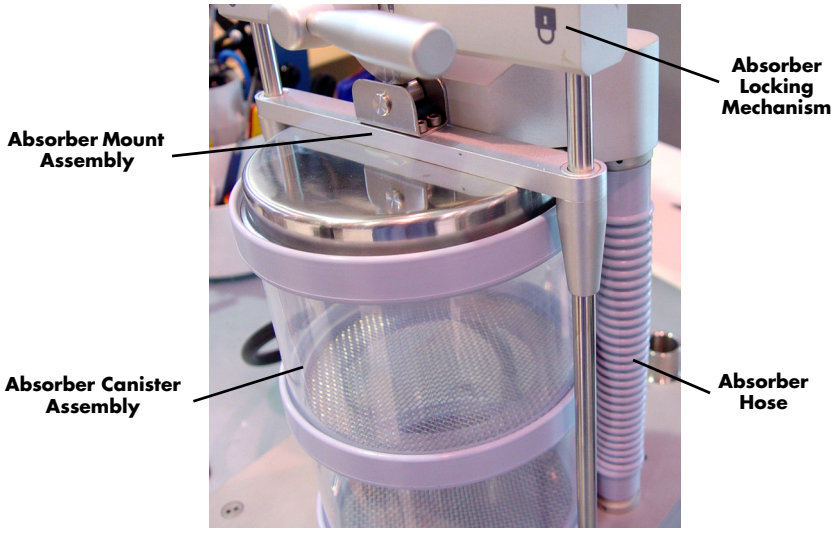


**FIGURE 6-2** Absorber Assembly

**2. Remove Absorber Guide Rods and Mounting Plate:**

**1.** Loosen the locking nuts on (2) Absorber Guide Rods.

**2.** Remove the (2) Absorber Guide Rods by unscrewing them from the Breathing System Block.

**3.** Remove Gasket and Screen from Absorber Mounting Plate.

**4.** Remove (3) philips head screws with (3) associated washers securing the Absorber Mounting Plate.

**5.** Remove the Absorber Mounting Plate

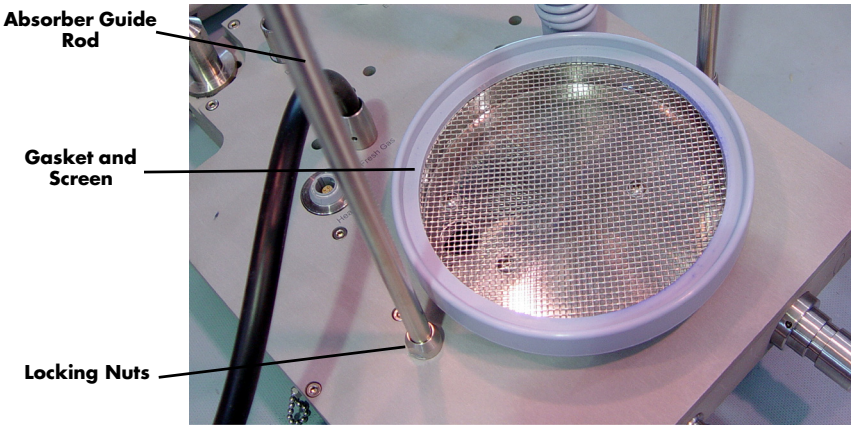


**FIGURE 6-3** Absorber guide rods and mounting plate

### 3. Remove Breathing System parts:

**1.** Remove the following parts from the Breathing System:

- APL Valve
- Breathing Circuit
- Manual Bag
- Bag Arm
- Bellows Cover
- Airway Pressure (PAW) Gauge
- Bellows
- Bellows Cover Base Gasket
- O2 Sensor Assembly
- Inspiratory Check Valve Assy
- Drive Gas Tube
- CGO Hose
- Heater Cable
- Pneumatc Hose
- Scavenger Hose
- Bellows Support Cage (if available)

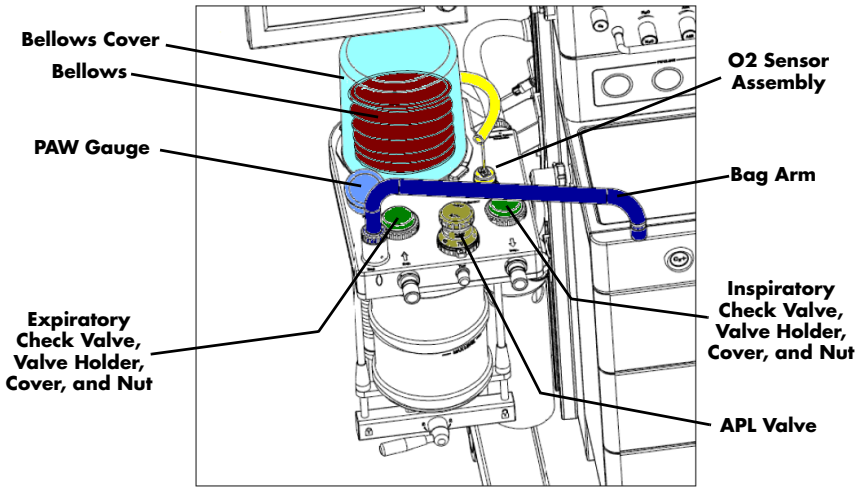


**FIGURE 6-4** Breathing System

**4. Remove Breathing System bottom block:**

1. Remove (15) 3mm hex screws securing the bottom block of the Breathing System. Save the screws.
2. Remove the bottom block of the Breathing System by inserting a standard 12mm socket into the Absorber Port to hold down the block. Pull the installed Absorber Hose Port to separate bottom block.
3. Remove the 12mm socket from the Breathing System.

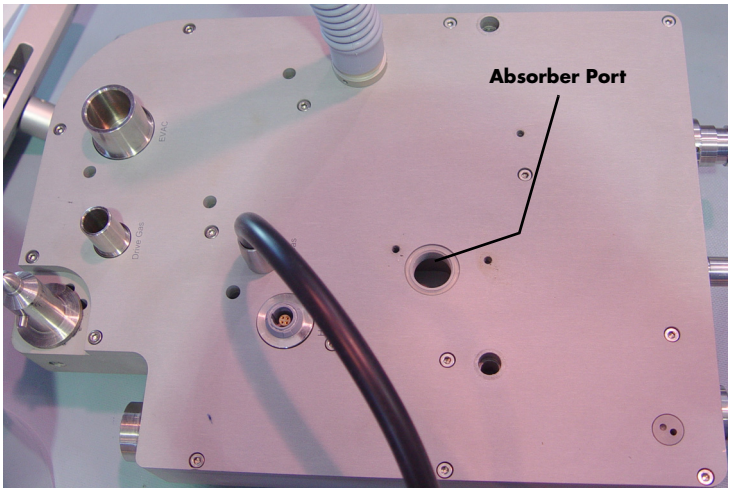


**FIGURE 6-5** Absorber port

**5. Remove and clean check valve:**

1. Using needle nose pliers, remove the bellows check valve by gently inserting into round holes, then prying loose.
2. Separate valve holder, check valve and valve seat.
3. Clean check valve, valve seat, and valve holder using a cloth or equivalent moistened with isopropyl alcohol .
4. Re-assemble check valve, valve seat, and valve holder.
5. Apply silicone lubricant PN 0510-00-0021 to valve seat o-ring.
6. Gently re-install bellows check valve assembly into port, assuring that there is no damage to the o-ring. Push down until it bottoms out.

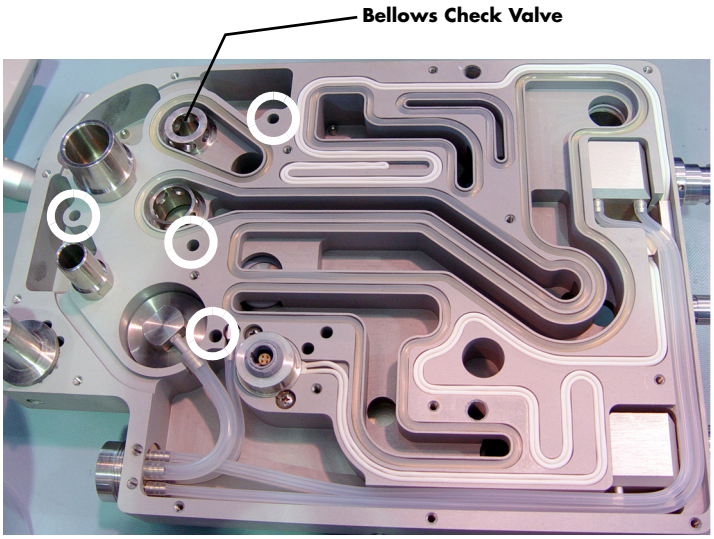


**FIGURE 6-6** Bellows check valve

**6. Inspect gaskets and secure bottom block:**

**1.** Inspect all internal gaskets and make sure they are seated properly.

**2.** Secure the bottom block with the original (15) 3mm hex screws:

- Loosely install all (15) screws
- Tighten the screws using the numbered sequence shown below.

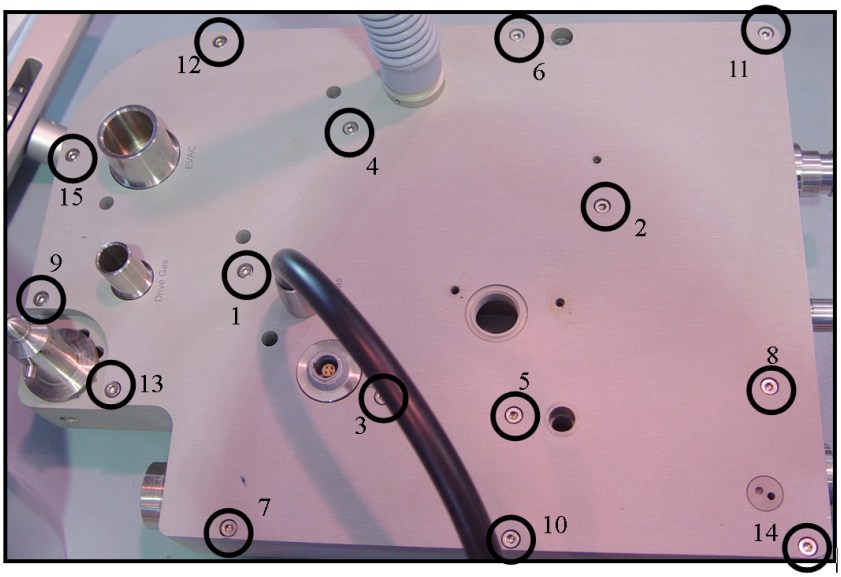


**FIGURE 6-7** Bottom block screws

### 7. Install absorber canister assembly:

**1.** Apply Loctite 243 to (3) screws of the Absorber Mounting Plate.

**2.** Secure mounting plate to Breathing System Block using (3) screws and (3) associated washers.

**3.** Apply Loctite 243 to the threads of (2) Absorber Guide Rods.

**4.** Install rods into block until rod height is 314 +/- 0.5 mm (old style breathing systems) or 303+/-0.25 mm (new style breathing systems) (see FIGURE 6-9).

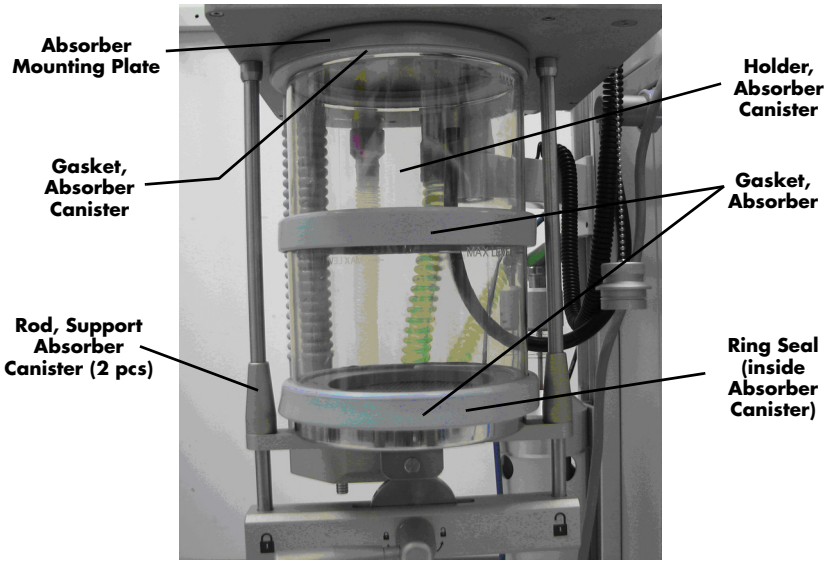


**FIGURE 6-8** Absorber Canister Assembly

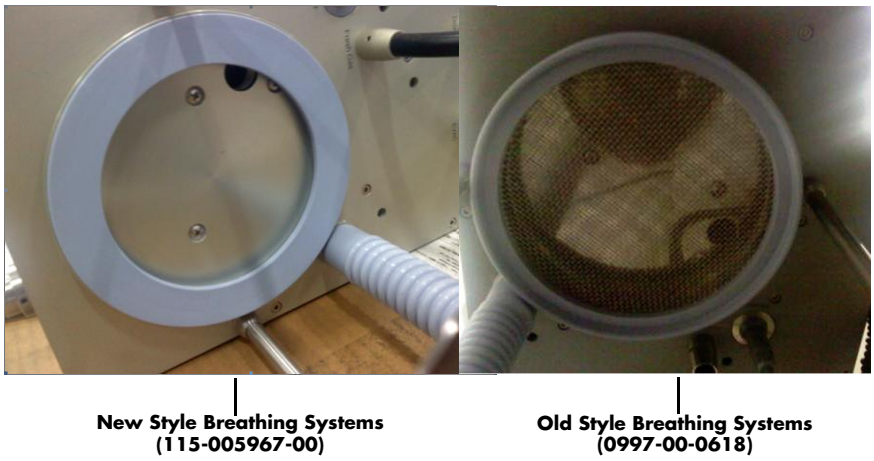


**FIGURE 6-9** Breathing System Styles

**8. Secure rods and install final assembly:**

**1.** Both rods must be equal in height.
Secure rods by tightening the locking nuts.

**2.** Install an Absorber Gasket and a Screen onto the Absorber Mounting Plate.

**3.** Insert Absorber Mount Assembly onto guide rods, noting the position of the Absorber Hose Port and Absorber Hose.

**4.** Install Absorber Hose onto Absorber Hose Port.

**5.** Install Absorber Locking Mechanism onto guide rods, noting the silk screening must face the front of the block. When assembling, put the locking mechanism lever in the "locked" position.

**6.** Secure the locking mechanism using the (2) original 4mm hex screws. Install the two Absorber Canister Assemblies.

**7.** Measure the distance between the absorber mount assembly plate at four different points. The difference in length should not be more than 1 mm.

**9. Perform tests on the check valve:**

**1.** Perform "Start-Up Tests" on page 6-15 and "Performance Verification" on page 6-27.

# 6.7 Battery Maintenance and Replacement

## 6.7.1 Battery Maintenance

1. The **AS3000** uses a sealed lead-acid battery. Due to the self-discharge characteristics of this type of battery, it is imperative that it is charged after 3 months of storage (or after extended periods of non-use). If not charged, a permanent loss of capacity may occur as a result of sulfation.
2. Check the battery run time every 12 months.
3. Replace batteries when operating time is less than 30 minutes or when the battery is 3 years old.

**NOTE: The sealed lead-acid batteries used in the system are maintenance free. They will perform reliably provided that they are kept in the charged state.**

4. Disposal of batteries should be conducted in accordance with local recycling statues and labeling shown on the battery pack.

## 6.7.2 Battery Replacement

1. Open the access door located at the rear of the **AS3000**.
2. Disconnect the battery connections.
3. Remove the old battery.
4. Ensure the new battery is electrically connected and secured in the same manner as the original one.
5. Close the access door.
6. Use only Approved Batteries (P/N 0997-00-0619).

# 6.8 Functional Tests

Refer to “Calibration” on page 5-1 if any values are out of specification.

## 6.8.1 Test Equipment and Special Tools Required

Refer to “Special Tools Required” on page 3-3 for a list of tools required for Running the functional tests.

## 6.8.2 Pressure Regulator Checks

### 6.8.2.1 Proportional Valve Regulator

1. Open the gas cover panel.
2. Remove the drive pressure source from the **AS3000**.
3. Disconnect the input hose from the Proportional Valve.
4. Connect a Digital Pressure Meter to the proportional valve input hose.
5. Reconnect the drive pressure source to the **AS3000**.
6. Verify the pressure displayed on the Pressure Meter is between 23.9 and 26.8 psi.
7. Remove the drive pressure source from the **AS3000**.
8. Remove the Pressure Meter and reconnect the input hose to the Proportional Valve.
9. Reconnect the drive pressure source to the **AS3000**.

**NOTE: If the proportional Valve Regulator is out of specification, calibration is required.**

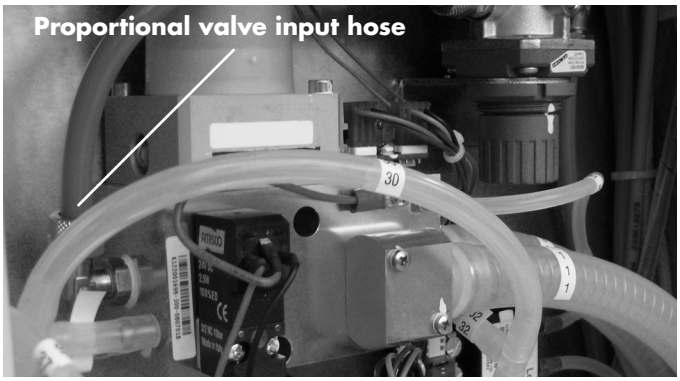


**FIGURE 6-10** The Proportional Valve Regulator

## 6.8.3 Gas Delivery System Tests

### 6.8.3.1 $O_2$ Flush Verification

1. Attach the Digital Flow Meter to the Common Fresh Gas Outlet.
2. Verify that the $O_2$ flush flow is between 35 to 50 L/min when pressing the $O_2$ flush valve.

### 6.8.3.2 $O_2$:$N_2O$ Ratio System

**For -01 units:**

1. Set the $O_2$ and $N_2O$ Flow Control Valves to minimum.
2. Rotate the $N_2O$ Flow Control Valve until the top of the $O_2$ flow meter's float rises to 1L/min.
3. Verify that the $N_2O$ flow is not higher than 3.7 L/min.
4. Lower the $N_2O$ flow to minimum.

**For -02 units:**

1. Set all flow control knobs to minimum.
2. Set the flow of $O_2$ to 1 L/min.
3. Open the $N_2O$ flow knob and verify that the $N_2O$ flow will not increase higher than 3.7 L/min.
4. Return flow control knobs to minimum.

## 6.8.4 Start-Up Tests

### 6.8.4.1 System Self Test.

1. Power ON the **AS3000**.
2. Wait until the System Self Test is complete

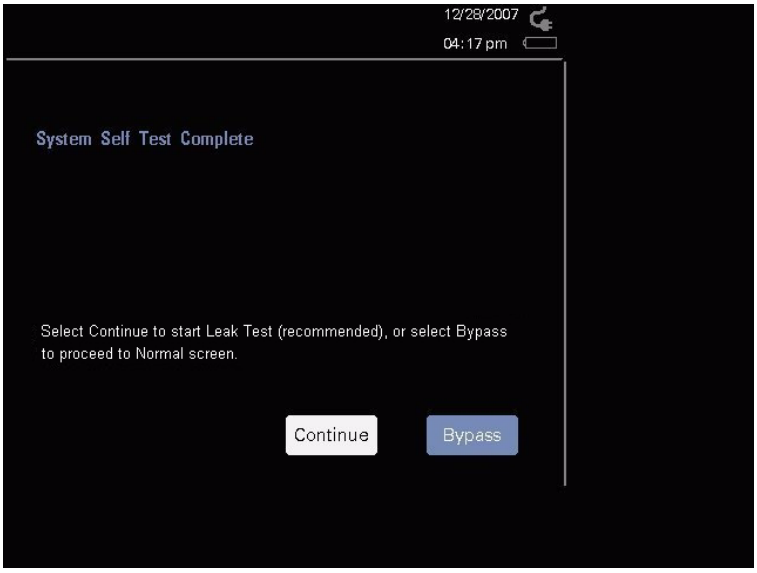


**FIGURE 6-11** Startup Self Test

3. Press **Continue** to prompt to the Safety Valve Test

### 6.8.4.2 Leak/Safety Valve Test

1. Follow the on-screen instructions.

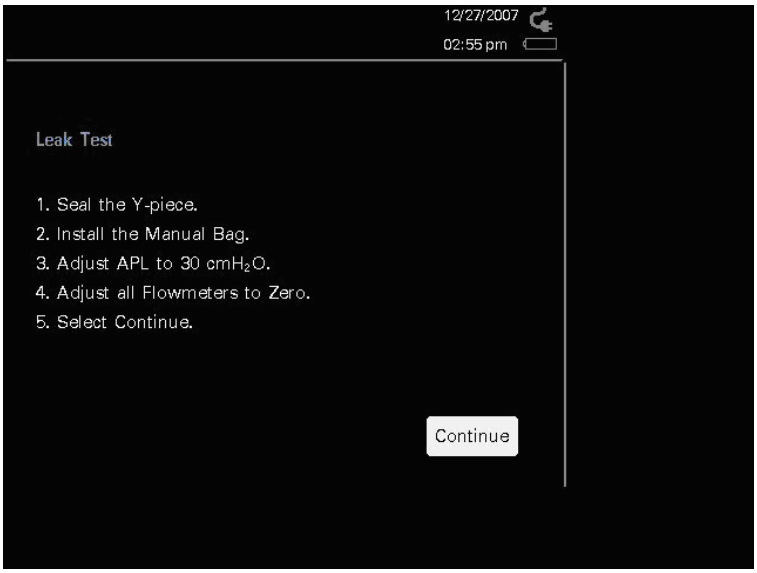


**FIGURE 6-12** Leak Test Setup

**2.** Select **Continue** to start the test.

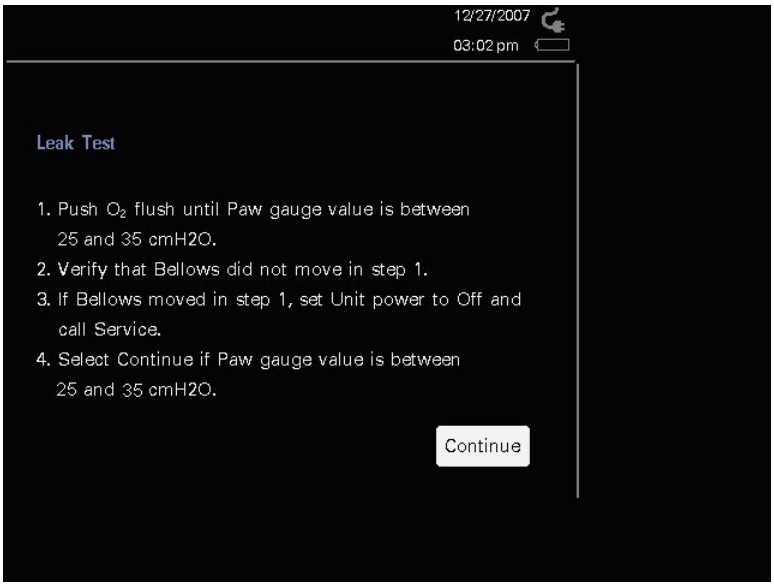


**FIGURE 6-13** Safety Valve Test Setup

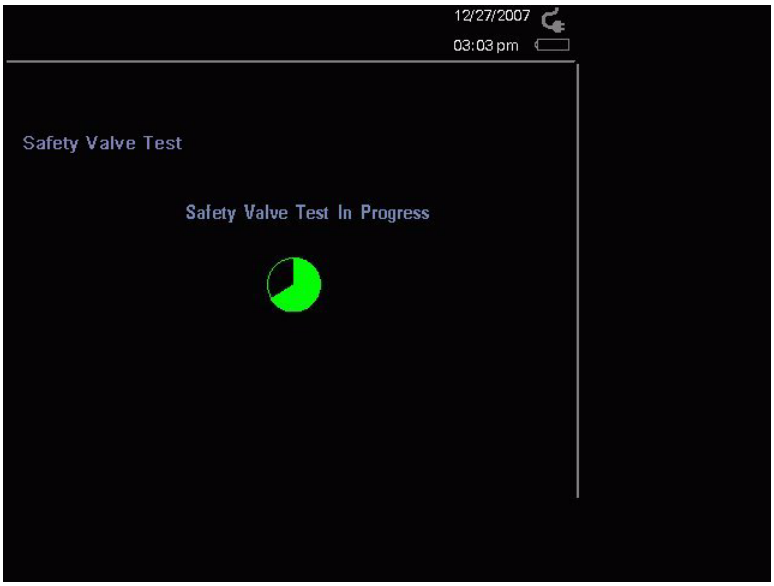


**FIGURE 6-14** Safety Valve Test in Progress

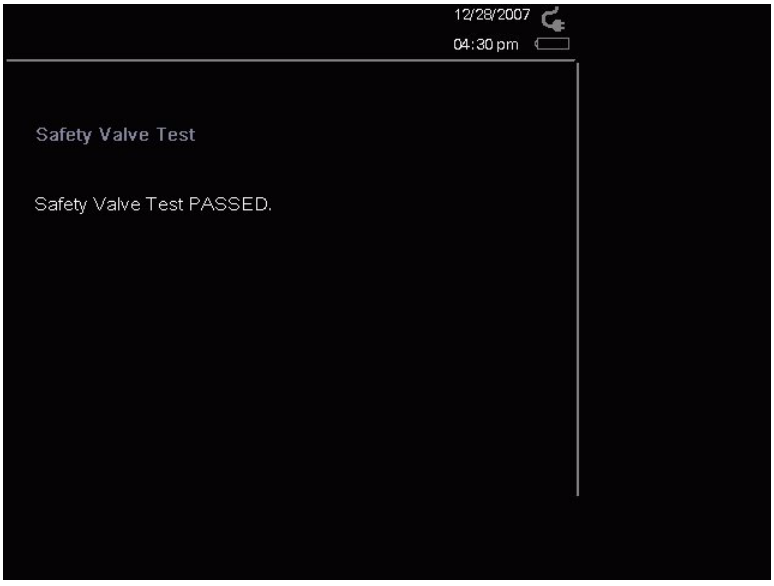


**FIGURE 6-15** Safety Valve Test Passed Message

**3.** After 3 seconds, the screen will prompt to the Leak Test.

### 6.8.4.3 Leak Test

**1.** Follow the on-screen instructions.

**2.** Select **Continue** to start the test.

**FIGURE 6-16** Leak Test Setup

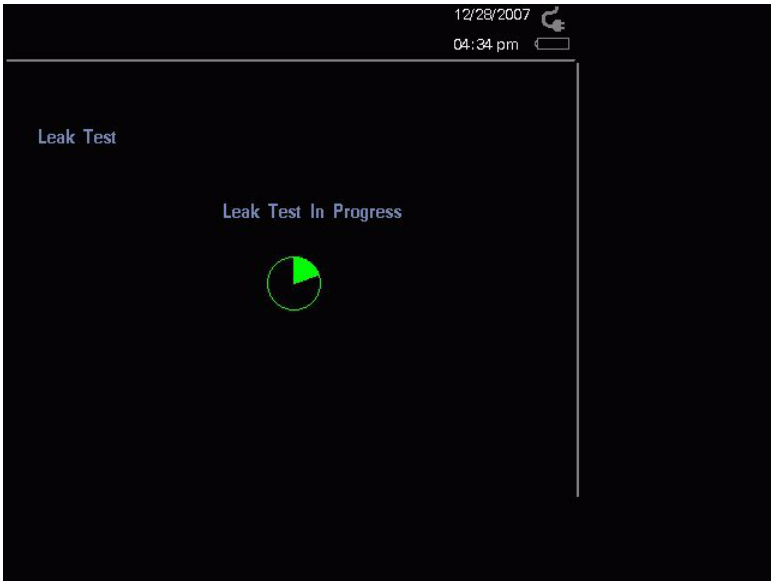


**FIGURE 6-17** Leak Test in Progress

**3.** Select **Continue** to prompt to the Compliance Test.

**FIGURE 6-18** Leak Test Results

### 6.8.4.4 Compliance Test

1. Follow the on-screen instructions.
2. Select **Continue** to start the test.

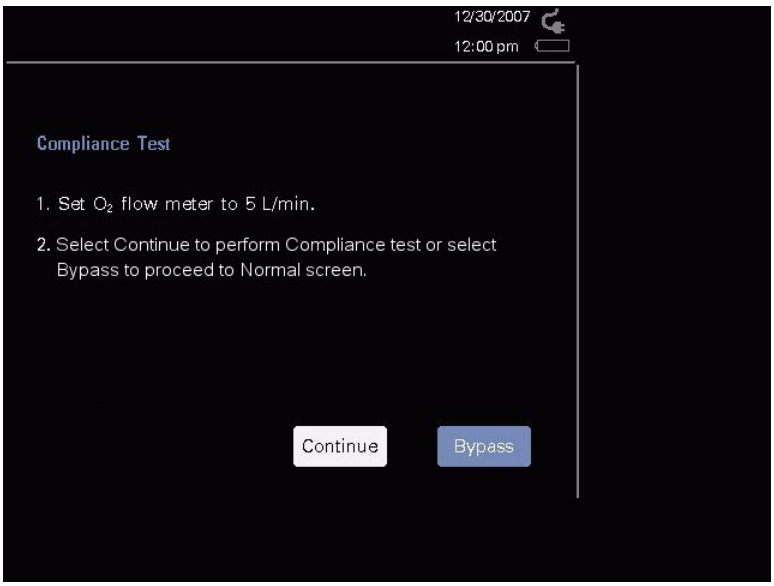


**FIGURE 6-19** Compliance Test Setup

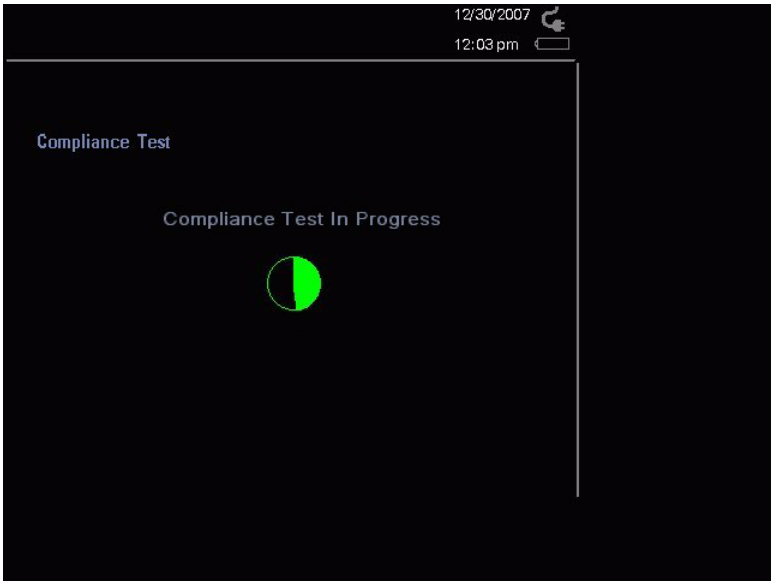


**FIGURE 6-20** Compliance Test in Progress

**3.** Select **Continue** to prompt to the Normal Screen.

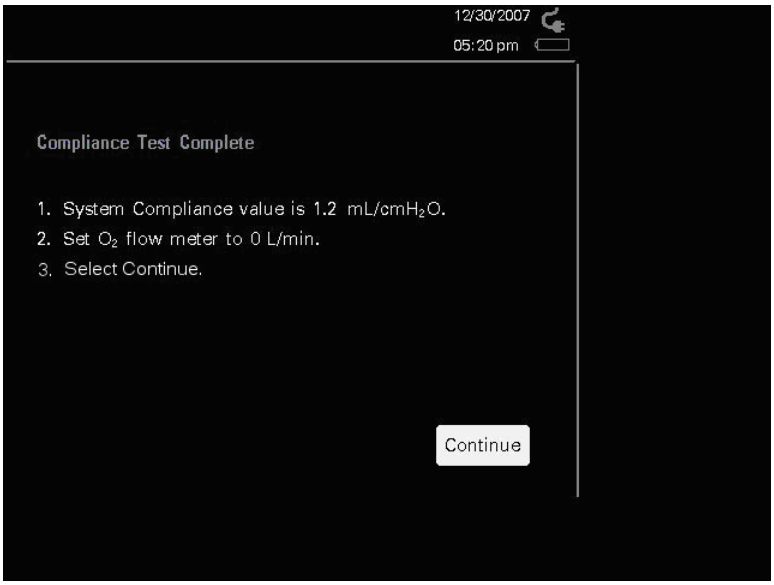


**FIGURE 6-21** Compliance Test Results

### 6.8.4.5 Manual Leak Test

**NOTE:** **The Manual Leak Test detects smaller leaks than can be detected in the Automatic Leak Test.**

**1.** Ensure that the gas pressure for $O_2$, $N_2O$, and AIR are at 50 ±10 psi.

**2.** Power ON the **AS3000**.

**3.** Attach a reusable-silicone-rubber breathing circuit to the Breathing System.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**4.** Tightly connect the Y-fitting on the breathing circuit to the test port.

**5.** Attach a breathing bag to the bag arm.

**6.** Set the APL Valve to the fully closed position (**70** $cmH_2O$).

**7.** Rotate the $O_2$ Flow Control Valve until 50 $cmH_2O$ pressure is observed on the Airway Pressure Gauge.

**8.** Verify that the flow required to stabilize the pressure is less than 300 mL/min.

### 6.8.4.6 Oxygen Sensor Calibration

**NOTE:** **Oxygen Sensor Calibration can be performed in all ventilation modes.**

**1.** Press the **MENU** key and then use the **Navigator™ Knob** to scroll to the **Calibrate** menu tab (see FIGURE 6-22). Select the **Start Calibration** button.

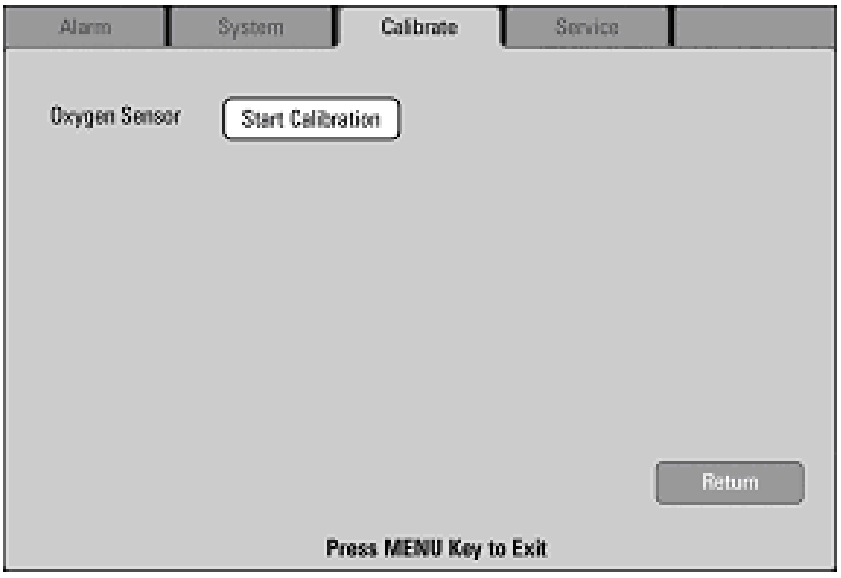


**FIGURE 6-22 Calibrate** Menu Tab

**2.** After the **Start Calibration** button has been selected, the screen shown in FIGURE 6-23 will be displayed, instructing the user to remove the oxygen sensor from the Breathing System and expose it to room air for at least 3 minutes before proceeding. After at least 3 minutes have passed, select the **Next** button to initiate the calibration process. The progress bar shown in FIGURE 6-24 will be displayed.

**NOTE:** **If the system is going to be used during the calibration, insert the $O_2$ cell plug into the port from which the oxygen sensor was removed using a push and turn motion.**

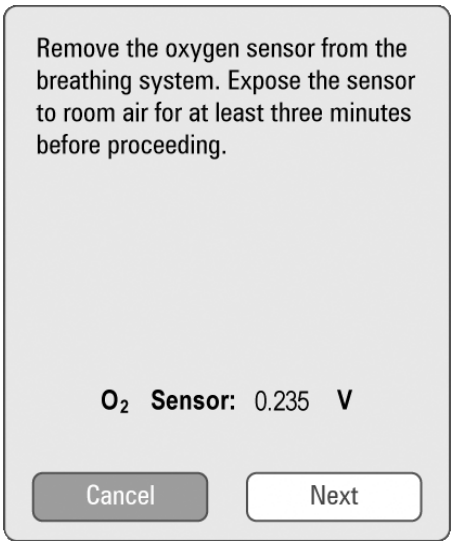


**FIGURE 6-23** Oxygen Sensor Calibration Instructions

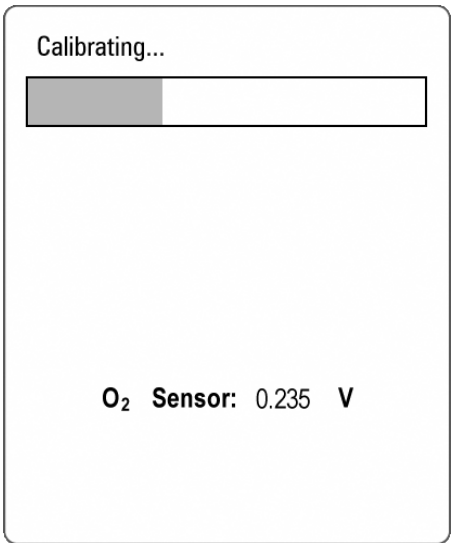


**FIGURE 6-24** Oxygen Sensor Calibration Progress Bar

**3.** Proceed based on one of the following two conditions:

- **If the calibration is successful,** the screen shown in FIGURE 6-25 will be displayed, instructing the user to reinstall the oxygen sensor into the Breathing System. Select the **Done** button to complete the process.
- **If the calibration fails,** the screen shown in FIGURE 6-26 will be displayed, instructing the user to either repeat the calibration (by selecting the **Repeat Cal** button) or to replace the oxygen sensor. If the oxygen sensor must be replaced, select the **Exit** button, replace the oxygen sensor using a push and turn motion, and then repeat the calibration.

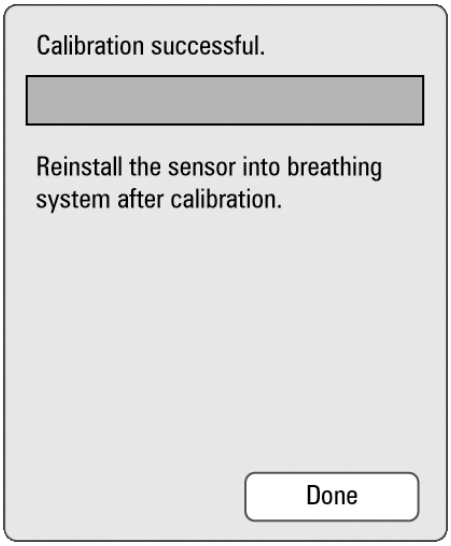


**FIGURE 6-25** Oxygen Sensor Calibration Successful

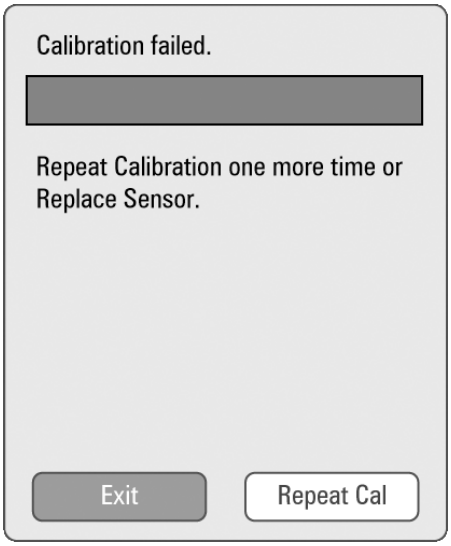


**FIGURE 6-26** Oxygen Sensor Calibration Failed

## 6.8.5 Pneumatic Leak Tests

### 6.8.5.1 $N_2O$ Cylinder Leak Test

1. Remove the $N_2O$ line pressure hose from the line pressure inlet on the **AS3000**.
2. Mount a full $N_2O$ cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the $N_2O$ cylinder until its pressure gauge indicates cylinder pressure.
4. Close the $N_2O$ cylinder.
5. The $N_2O$ cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

### 6.8.5.2 $O_2$ Cylinder Leak Test

1. Remove the $O_2$ line pressure hose from the line pressure inlet on the **AS3000**.
2. Mount a full $O_2$ cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the $O_2$ cylinder until its pressure gauge indicates cylinder pressure.
4. Close the $O_2$ cylinder.
5. The $O_2$ cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

### 6.8.5.3 AIR Cylinder Leak Test

1. Remove the AIR line pressure hose from the line pressure inlet on the **AS3000**.
2. Mount a full AIR cylinder to the rear panel yoke. If necessary, place a new clean tank washer between the cylinder and the yoke to minimize any leaks at the yoke connection.
3. Open the AIR cylinder until its pressure gauge indicates cylinder pressure.
4. Close the AIR cylinder.
5. The AIR cylinder pressure gauge should not drop more than 10% of its initial pressure over 1 minute.

### 6.8.5.4 Line Supply Check Valves Test

1. Connect and open a full gas cylinder on each yoke.
2. Verify the cylinder gauges operate.
3. Remove each line pressure hose one at a time from the wall supply inlet.
4. Verify no gas is escaping from any of the three central supply high pressure hoses connected to the **AS3000** using a Digital Flow Meter.
5. Verify there is no external damage to the gas supply inlet coupling on the **AS3000**.
6. Reattach each central supply gas hose to the wall supply inlets.

### 6.8.5.5 $N_2O$ Line Pressure Leak Test

1. Remove the $N_2O$ cylinder from the **AS3000**.
2. Connect the $N_2O$ line pressure hose to the line pressure inlet on the **AS3000**.
3. Pinch the $N_2O$ line pressure hose to stop $N_2O$ line flow.
4. Remove the $N_2O$ line pressure hose from the $N_2O$ line source.
5. The $N_2O$ line pressure gauge should not fall more than 2 psi in 20 seconds.
6. Reconnect the $N_2O$ line pressure and remove the pinch in the hose.

### 6.8.5.6 $O_2$ Line Pressure Leak Test

1. Remove the $O_2$ cylinder from the **AS3000**.
2. Connect the $O_2$ line pressure hose to the line pressure inlet on the **AS3000**.
3. Pinch the $O_2$ line pressure hose to stop $O_2$ line flow.
4. Remove the $O_2$ line pressure hose from the $O_2$ line source.
5. The $O_2$ line pressure gauge should not fall more than 2 psi in 20 seconds.
6. Reconnect the $O_2$ line pressure and remove the pinch in the hose.

### 6.8.5.7 AIR Line Pressure Leak Test

1. Remove the AIR cylinder from the **AS3000**.
2. Connect the AIR line pressure hose to the line pressure inlet on the **AS3000**.
3. Pinch the AIR line pressure hose to stop AIR line flow.
4. Remove the AIR line pressure hose from the AIR line source.
5. The AIR line pressure gauge should not fall more than 2 psi in 20 seconds.
6. Reconnect the AIR line pressure and remove the pinch in the hose.

### 6.8.5.8 Cylinder Supply Check Valves Test

1. Close and remove all gas cylinders from the **AS3000**.
2. Verify the cylinder gauges return to zero.
3. Using the Digital Flow Meter, verify that no gas is escaping from any of the three yoke connections on the **AS3000**.
4. Verify there is no external damage to the gas cylinder or yoke pins.
5. Reconnect the cylinder(s) as necessary.

## 6.8.6 Breathing System Checks

### 6.8.6.1 Waste Gas Scavenger Test (if available)

1. Connect one end of the low pressure waste gas hose to the port on the Waste Gas Scavenger Assembly. Connect the other end of the hose to the EVAC port.

**NOTE: If operating the AS3000 with other types of waste gas scavenging, ensure that waste gases are directed from the EVAC port to that scavenging system.**

2. Connect the respiratory gas monitor exhaust output to the barbed fitting port on the Waste Gas Scavenger Assembly.
3. Cap any open ports on the waste gas scavenger assembly.
4. Ensure that the waste gas scavenger flow adjustment is able to be set throughout its full range.

### 6.8.6.2 Internal Gas Connections Test

1. Close and remove all gas cylinders from the **AS3000**
2. Connect only the AIR line pressure hose to the **AS3000** from the wall supply. Leave all other line pressure hoses disconnected.
3. With the **AS3000** powered OFF, rotate the AIR flow control knob to ensure a continuous flow increase throughout its full range
4. Disconnect the AIR line pressure hose from the **AS3000**, and connect the $O_2$ line pressure hose from the wall supply.
5. Fully rotate the $N_2O$ flow control knob and verify that there is no flow.
6. Fully rotate the AIR flow control knob and verify that there is no flow.

### 6.8.6.3 Drive Gas Pressure Loss Alarm, $N_2O$ Cutoff Test

1. Set the $O_2$ flow to 2 L/min using the flow control valve.
2. Set the $N_2O$ flow to 2 L/min using the flow control valve.
3. Set the AIR flow to 2 L/min using the flow control valve.
4. Interrupt the $O_2$ supply to the **AS3000**.
5. Verify that the flow of $N_2O$ and $O_2$ stops within 2 minutes and that the flow of AIR (if available) continues to flow at 2 L/min.
6. Verify the following alarms are activated:
   - **$O_2$ Supply Failure** appears on the screen
   - An alarm tone sounds.

## 6.8.7 Performance Verification

### 6.8.7.1 Standby Mode Ventilation Test

1. Ensure that the gas pressure for $O_2$, $N_2O$, and AIR are at 50 ±10 psi.
2. Power ON the **AS3000**.
3. Perform the start up tests per the on-screen instructions. Ensure successful completion.
4. Attach a breathing circuit and test lung to the Y-fitting of the breathing circuit.

**NOTE: For testing purposes always use a reusable breathing circuit.**

5. Set the APL Valve to approximately **15** $cmH_2O$.
6. Set the AIR flow to 5 L/min using the flow control valve.
7. Squeeze the breathing bag once every 10 seconds to inflate and deflate the test lung to approximately 20 $cmH_2O$ of pressure.
8. Verify the inflation and deflation of the test lung.

### 6.8.7.2 Manual Mode Ventilation Test

1. Set the Ventilation Mode to **MANUAL**.
2. Set the APL Valve to approximately **25** $cmH_2O$. Push the $O_2$ Flush button to fill the breathing bag.
3. Set the AIR flow to 1 L/min using the flow control valve.
4. Squeeze the breathing bag once every 3 seconds.
5. Verify the inflation and deflation of the test lung.
6. Verify that an airway pressure waveform and all numeric values appear on screen during bag compressions.
7. Stop squeezing the breathing bag and set the APL Valve to the open position (**SP**).

### 6.8.7.3 APNEA Alarm Test

1. While in the Manual Ventilation Mode, stop ventilating the test lung.
2. Verify that the following APNEA alarm signals activate at approximately 60 seconds from the last bag compression.
   - **APNEA** appears on the screen.
   - An alarm tone sounds.

### 6.8.7.4 Alarm MUTE Test

1. While the APNEA alarm is sounding, press the **MUTE** key.
2. Verify the audio portion of the alarm stops and resumes after 2 minutes.

### 6.8.7.5 CMV Adult Ventilation Mode Test

**1.** Attach a breathing circuit and breathing bag.

**NOTE: For testing purposes always use a reusable breathing circuit.**

**2.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**3.** Attach a Vent Tester between the EXP port and the expiratory hose.

**4.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**5.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | CMV |
| Tidal Volume - **$V_T$** | 600 |
| Breath Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - **$T_P$** | 10 |
| PEEP - **PEEP** | Off |

**6.** Select **CMV** again to begin ventilation.

**7.** Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.

**8.** Verify the Tidal Volume display is within 15% of the set value within approximately 1 minute from the start of ventilation.

**9.** Verify the Tidal Volume display is within 15% of the delivered volume measured with the Vent Tester within approximately 1 minute from the start of ventilation.

**10.** Verify the measured $O_2$ concentration is at least 97% after 5 minutes.

**11.** Set the AIR flow to 3 L/min and set the $N_2O$ and $O_2$ flow rates to minimum flow.

**12.** Verify the measured $O_2$ concentration is 21% ±3% vol. % after 5 minutes.

### 6.8.7.6 CMV Child Ventilation Mode Test

**1.** Attach a breathing circuit and breathing bag.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**2.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**NOTE:** **Limit the volume in the test lung to provide sufficient airway pressure to satisfy the Low Peak Pressure alarm. Or reduce the Peak Pressure alarm limit to a lower valve to prevent the alarm when using an adult test lung.**

**3.** Attach a Vent Tester between the EXP port and the expiratory hose.

**4.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**5.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Child |
| Ventilation Mode | CMV |
| Tidal Volume - **$V_T$** | 120 |
| Breath Rate - **freq** | 20 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - **$T_P$** | 10 |
| PEEP - **PEEP** | Off |

**6.** Select **CMV** to begin ventilation.

**7.** Verify that the pressure waveform, Tidal Volume, Mean or Plateau Pressure, Resp. rate and minute volume values appear on the screen.

**8.** Verify the Tidal Volume display is within 25ml or ±15% of the delivered volume (whichever is greater) measured with the Vent Tester within approximately 1 minute from the start of ventilation.

**9.** Verify the delivered volume as measured by a Vent Tester at the expiratory port, is within 17% of the Tidal Volume set value within approximately 1 minute from the start of ventilation.

### 6.8.7.7 Airway Disconnect Alarm Test

**1.** While the ventilator is running, disconnect the expiratory limb from the Expiratory Port on the Breathing System.

**2.** Verify the following airway pressure disconnect alarm signals activate:

- **APNEA** message appears on the screen.
- **Low Airway Pressure** message appears on the screen.
- An alarm tone sounds.

## 6.8.7.8 PCV Adult Ventilation Mode Test

**1.** Attach a breathing circuit and breathing bag.

**NOTE:** **For testing purposes always use a reusable breathing circuit.**

**2.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**3.** Attach a Vent Tester between the EXP port and the expiratory hose.

**4.** Set the $O_2$ flow to 3 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**5.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | PCV |
| Target Pressure - $\mathbf{P_{TARGET}}$ | 20 |
| Breath Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| PEEP - **PEEP** | Off |
| Inspiratory Slope - $\mathbf{T_{slope}}$ | 0.5 |

**6.** Select **PCV** to begin ventilation.

**7.** Verify the Peak Pressure reading of the display is within ±4 $cmH_2O$ of the Peak Pressure measured with the Vent Tester.

**8.** Verify that the pressure waveform, Tidal Volume, Resp. Rate and minute volume values appear on the screen.

**9.** Verify that the PEAK Value reaches 20 ±4 $cmH_2O$ within five breaths from the start of ventilation.

### 6.8.7.9 Pressure Support (PS) Ventilation Mode Test

**1.** Attach a breathing circuit and breathing bag.

**NOTE: For testing purposes always use a reusable breathing circuit.**

**2.** Attach an adult test lung to the Y-fitting of the breathing circuit.

**3.** Attach a Vent Tester between the EXP port and the expiratory hose.

**4.** Set the $O_2$ flow to 1 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**5.** Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Vent Dial Patient Type | Adult |
| Vent Mode Ventilation Mode | PS |
| Differential Pressure - **ΔP** | 20 |
| PEEP - **PEEP** | Off |
| Flow Trigger - **Trigger** | 3 |
| Inspiratory Slope - $\mathbf{T_{slope}}$ | 0.5 |
| Minimum frequency - $\mathbf{freq_{MIN}}$ | 2 |

**6.** Select **PS** to begin ventilation.

**7.** Begin triggering breaths by slightly squeezing the test lung and releasing. Maintain a continuous breath rate.

**8.** Verify that a pressure waveform and all ventilation parameters appear on the screen.

**9.** Verify that the Peak Pressure reading on the display is ±4 the value of ΔP + PEEP.

**10.** Stop triggering breaths.

**11.** Verify that after 30 seconds the ventilator delivers a breath and displays the message **APNEA BACKUP**.

**12.** Verify the system ventilates with a frequency of 2 bpm

## 6.8.8 Alarms and Failsafe Functions

### 6.8.8.1 Set Up

1. Ensure that the gas pressure for $O_2$, $N_2O$, and AIR are at 50 ±10 psi.
2. Power ON the **AS3000**.
3. Perform the Startup Tests per the on-screen instructions. Ensure successful completion.
4. Attach a breathing circuit and breathing bag.

**NOTE: For testing purposes always use a reusable breathing circuit.**

5. Attach an adult test lung to the Y-fitting of the breathing circuit.
6. Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.
7. Set the ventilator controls to:

| VENTILATOR CONTROLS | VENTILATOR SETTINGS |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | CMV |
| Tidal Volume - **$V_T$** | 600 |
| Breath Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - **$T_P$** | 10 |
| PEEP - **PEEP** | Off |

8. Select **CMV** to begin ventilation.

### 6.8.8.2 Low $FiO_2$ Alarm Test

1. Set the low $FiO_2$ Alarm limit to 50% $O_2$.
2. Set the AIR flow control valve to 5 L/min.
3. Set the $FiO_2$ flow controller to minimum flow.
4. Verify the following Low $FiO_2$ alarm signals activate, within three ventilation cycles:
   - **Low $FiO_2$** message appears on the screen.
   - An alarm tone sounds.
5. Set the Low $FiO_2$ alarm limit to 18%.
6. Verify the alarm signals cease.

### 6.8.8.3 High $FiO_2$ Alarm Test

1. Set the high $FiO_2$ Alarm limit to 49% $O_2$.
2. Set the $FiO_2$ flow control valve to 5 L/min.
3. Set the AIR flow controller to minimum.
4. Verify the following High $FiO_2$ alarm signals activate:
   - **High $FiO_2$** message appears on the screen.
   - An alarm tone sounds.
5. Set the high $FiO_2$ alarm limit to the max setting.
6. Verify the alarm signals cease.

### 6.8.8.4 Peak Pressure Alarms Test

1. Set the PAW low alarm to the lowest setting.
2. Set the PAW high alarm limit set point about 5 to 8 digits below the Peak Pressure displayed on the upper left of the screen.
3. Verify the following (high) peak pressure alarms activate:
   a. **High Airway Pressure** message appears on the screen.
   b. An alarm tone sounds.
   c. Inspiration ends and expiration begins as the pressure meets the high alarm limit.
4. Set the PAW high alarm limit set point to 65 ($cmH_2O$).
5. Verify the alarms signals cease.
6. Set the PAW low alarm limit set point to 50 ($cmH_2O$).
7. Verify the following (low) peak pressure alarms activate:
   a. **Low Airway Pressure** message appears on the screen.
   b. An alarm tone sounds.
8. Set the PAW low alarm limit to 12 ($cmH_2O$).
9. Verify the alarm signals cease.

### 6.8.8.5 Minute Volume Alarm Test

1. Set the MV Low alarm limit set point to the highest value.
2. Verify the following alarms activate:
   - **Low MV** message appears on the screen.
   - An alarm tone sounds.
3. Set the MV Low alarm limit to minimum setting.
4. Verify the the alarm signals cease.
5. Set the MV High alarm limit set point to the lowest value.
6. Verify the following alarms activate:
   - **High MV** message appears on the screen.
   - An alarm tone sounds.
7. Set the MV High alarm limit set point to the highest value
8. Verify that the alarm signals cease.

## 6.8.9 Miscellaneous Tests

### 6.8.9.1 Test the Line Voltage Alarm

1. Before starting this test, verify that the battery is fully charged. (The battery icon in the upper right corner of the screen is solid when the battery is fully charged.)
2. Interrupt AC line voltage.
3. Verify that the following alarms activate:
   - An alarm tone sounds.
   - **AC Power Failure** message appears on the screen.
4. Verify that a fully charged battery operates the ventilator for a minimum of 45 minutes.
5. Plug the **AS3000** into AC line voltage.
6. Verify that the alarm signals cease.
7. Verify the presence of the battery charging icon in the upper right corner of the screen (status bar moving from right to left).

### 6.8.9.2 Wheel Brakes Test

1. Verify that each front wheel brake operates.

### 6.8.9.3 Work Light Test

1. Turn on the work light located on the bottom side of the top panel.
2. Verify that it lights in both on positions.

### 6.8.9.4 Auxiliary Flowmeter

1. Verify an AIR flow of 15 L/min can be obtained by connecting the auxiliary AIR hose to the pressure source and opening the flow meter.
2. Verify an $O_2$ flow of 15 L/min can be obtained by connecting the auxiliary $O_2$ hose to the pressure source and opening the flow meter.

### 6.8.9.5 Patient Suction Regulator (if available)

1. Set the suction regulator's selection dial to **LINE**.
2. Verify maximum suction vacuum on the regulator's gauge.
3. Set the suction regulator's selection dial to **REGULATE**.
4. Verify the suction vacuum is adjustable on the regulator's gauge.
5. Set the suction regulator's selection dial to **OFF**.

## 6.8.10 Vaporizers

### 6.8.10.1 Vaporizer Interlock Test

1. Attach two vaporizers to the Vaporizer Mounting Manifold and lock them in place.
2. Rotate either of the vaporizer dial to **3%** agent.
3. Verify that the other vaporizer dial cannot be rotated to a setting.
4. Set both vaporizer dials to **0**.
5. Rotate the other vaporizer dial to **3%**.
6. Verify that the first vaporizer dial cannot be rotated.
7. Rotate both vaporizer dials to **T** and remove both vaporizers.
8. Verify that the locking spring is intact.
9. Reconnect both vaporizers to the Vaporizer Mounting Manifold.

### 6.8.10.2 Vaporizer Accuracy Test

**WARNING: Avoid exposure to respiratory gases by always directing the fresh gas flow from the fresh gas outlet to the waste gas scavenger.**

1. Remove the Fresh Gas Hose from the Common Gas Outlet.
2. Insert an endo-tracheal tube mask elbow adapter with monitoring port, into the Common Gas Outlet.
3. Set the APL Valve to **70** $cmH_2O$.
4. Remove the Waste Gas Scavenger Hose from the bottom of the Breathing System EVAC port. Leave the connection to the waste gas scavenger attached.
5. Set the waste gas scavenger flow above the minimum setting.
6. Adapt the Waste Gas Scavenger Hose to connect to the endo-tracheal tube mask elbow, now connected to the Common Gas Outlet port.
7. Attach the Agent Analyzer meter sampling tube to the endo-tracheal tube mask elbow's monitoring port.
8. Fill the vaporizer with anesthetic agent (if necessary).

**NOTE: Do not overfill by filling past the indicator line on the vaporizer.**

9. Test the vaporizer accuracy per the Dräger Vapor 2000 instructions (See section 6.8.10.4), or see the appropriate vaporizer manual for testing details.
10. Test each vaporizer in turn.
11. Test any vaporizer on the Vaporizer Storage Mount.
12. Remove the measuring equipment from the Common Gas Outlet.
13. Reconnect the Fresh Gas, and Waste Gas Scavenger Hoses.

### 6.8.10.3 Vaporizer Leak Test

**NOTE: Verify the system has passed the leak test without the vaporizers prior to this test.**

1. Verify that vaporizers are mounted correctly.
2. Ensure that the gas pressure for $O_2$, $N_2O$, and AIR are at 50 ±10 psi.
3. Power ON the **AS3000**.
4. Attach a reusable-silicone-rubber breathing circuit to the Breathing System.

**NOTE: For testing purposes always use a reusable breathing circuit.**

5. Tightly connect the Y-fitting on the breathing circuit to the test port.
6. Attach a breathing bag to the bag arm.
7. Set the APL Valve to the fully closed position (**70** $cmH_2O$).
8. Rotate the $O_2$ Flow Control Valve until 50 $cmH_2O$ pressure is observed on the Airway Pressure Gauge.
9. Verify that the necessary flow to stabilize the pressure is less than 300 mL/min.

### 6.8.10.4 Dräger Vapor 2000 Operating Instructions ARRB-F001

**1.** Fill Vaporizer - at least half full between minimum and maximum mark.

**2.** Allow the filled Vapor to warm up to room temperature of 20-24°C. Wait long enough for the temperature to equalize - the time will vary depending on the temperature differential '$\Delta$**T**'.

- 1 hour = up top 2°C
- 3 hours = ±6°C
- 4 hours = ±10°C
- 5 hours = ±20°C

**3.** Check anesthetic agent monitor. Perform zero calibration of monitor with the desired gas (AIR or $O_2$)

**4.** Connect monitor to fresh gas outlet or Y-fitting. Make sure that all connections are leak-tight.

**5.** Connect and start scavenging system.

**6.** Switch OFF ventilator or set vent pressure to less than 5 $cmH_2O$.

**7.** Set monitor to anesthetic agent being used and to continuous measurement.

**8.** Set flow between 2.5 and 4 L/min AIR. Use $O_2$ if AIR is not available.

**9.** Check **0** and **T** marks, 1 vol.% 4 vol % and at least three other concentrations.

**10.** Adjust control dial on the vaporizer.

**11.** Read concentration after it has reached steady state.

**12.** Correct measured values for the effect of carrier gas used. If AIR no correction required. If $O_2$ use following correction factor:

- Measured value vol.% = <1.0, correction = -0.05 vol.%
- Measured value vol.% = 1.0 - 2.0, correction = -0.1 vol.%
- Measured value vol.% = 2.5 - 4.0, correction = -0.2 vol.%
- Measured value vol% = 5.0 - 8.0, correction = -0.3 vol.%

**13.** If the value displayed on the monitor is in % partial pressure, no correction is required. If in vol.% convert to partial pressure:

- Concentration [% partial pressure] = measured value [vol.%] x atmospheric pressure [$cmH_2O$] / 1013 $cmH_2O$

**14.** For setting **0** and **T** there should be no output of anesthetic agent.

- At 1 vol.%; 0.8 - 1.2 vol.% *
- At 2 vol.%; 1.8 - 2.2 vol.% *
- At 3 vol.%; 2.8 - 3.2 vol.% *
- At 4 vol.%; 3.8 - 4.2 vol.% *
- At 5 vol.%; 4.8 - 5.2 vol.% *
- At 6 vol.%; 5.7 - 6.3 vol.% *
- At 7 vol.%; 6.7 - 7.3 vol.% *
- At 8 vol.%; 7.7 - 8.3 vol.% *

  * = Correct for temperature and carrier gas if necessary.

**15.** Switch off the vaporizer until **0** engages.

**16.** Switch off the AIR or $O_2$ flow.

## 6.8.11 Electrical Tests

**CAUTION: Perform the electrical safety inspection as the last step after completing a repair or after routine maintenance. Perform this inspection with all covers, panels, and screws installed.**

### 6.8.11.1 Convenience AC Outlets Test

1. Verify AC voltage is present at each AC outlet with the **AS3000** Mains switch in both the **ON** and **OFF** positions.

### 6.8.11.2 Electrical Safety Inspection Test

**NOTE: Perform the electrical safety inspection as the last step after completing a repair or after routine maintenance. Perform this inspection with all covers, panels, and screws installed.**

1. Unplug the Power cable(s) from the convenience receptacles at the rear of the **AS3000**.
2. Plug the **AS3000** into a Safety Analyzer.
3. Connect the case ground lead of the analyzer to the U-blade ground of one of the convenience receptacles. Perform the following tests with the case grounded:
    - Normal polarity
    - Normal polarity with open neutral
4. Perform the following tests with the case ungrounded:
    - Normal polarity
    - Normal polarity with open neutral
    - Reverse polarity
5. Verify that the maximum leakage current does not exceed 300 µA (0.3 mA).

## 6.8.12 AS3000 Installation Checklist

Refer to section 2.0 (pg. 2-1) ''Installation Guide'' for the installation checkout procedure. Complete each step to check the functionality of the anesthesia machine prior to clinical use. Also, perform the installation checkout procedure after installation, reinstallation, servicing or after any periodic maintenance activity. This checklist does not replace periodic maintenance actions that must be performed to maintain peak performance.

# 6.9 Cleaning

## 6.9.1 Cleaning and Disinfecting the AS3000

Before cleaning, switch off the **AS3000** and disconnect it from the mains.

**NOTE: See the "AS3000 Operating Instructions" (P/N: 0070-00-0684-XX) for more in-depth cleaning instructions.**

## 6.9.2 Cleaning and Sterilizing the Breathing System and Components

### Cleaning method and chemical

| COMPONENT | SOAP WATER | CHEMICALS CIDEX | STERILIZATION STEAM AUTOCLAVE | MAXIMUM TEMPERATURE (°F/°C) |
|---|---|---|---|---|
| Absorber canister | yes | yes | no | |
| Airway pressure gauge | no | no | no | |
| APL Valve | yes | yes | no | |
| Valve cover and valve nut | yes | yes | no | |
| Breathing System module (without the above mentioned) | yes | yes | yes | 273°F/134°C |
| AGSS | yes | yes | no | |

*The components in the above table should be rinsed in warm water thoroughly and dried in air after cleaning or sterilizing.*

# 6.10 Preoperative Checklist

This checklist should be conducted before administering anesthesia.

**NOTE: This is a guideline which can be modified to accommodate variations in local clinical practice. Such local modifications should have appropriate peer review.**

If an anesthetist uses the same machine in successive cases, this checkout need not be repeated or may be abbreviated after the initial checkout.

1. **Inspect the system for:**
   - **a.** Identification number
   - **b.** Valid inspection sticker
   - **c.** Damage to flowmeters, vaporizers, gauges, and supply hoses
   - **d.** Complete Breathing System with adequate $CO_2$ absorbent Pre-Paks or loose fill
   - **e.** Correct mounting of gas cylinders in the yokes
   - **f.** Presence of the Tank Wrench

**2. Per manufacturers' specifications, turn ON the patient monitors to allow time for their warm-up (ECG, Blood Pressure, $SpO_2$, Gas Monitoring, etc.).**

**3. Prepare the Anesthetic Gas Scavenging System (AGSS).**

**a.** Remove the AGSS from the **AS3000**. While viewing the float, turn the AGSS upside down to verify whether the float moves freely along its shaft. Replace the float as necessary. Reconnect the AGSS to the **AS3000**.

**b.** Connect the vacuum hose to the vacuum port on the AGSS. Adjust the position of the float to be between the Min and Max lines by turning its flow adjustment knob (counterclockwise increases flow, clockwise decreases flow).

**c.** Drain any moisture from the waste gas hose. Connect the waste gas hose to the AGSS waste gas port.

**4. Verify that:**

**a.** Flow-control valves are off

**b.** Vaporizers are off

**c.** Vaporizers are filled.

**d.** Vaporizer Filler caps are sealed tightly.

**5. Check oxygen ($O_2$) cylinder supply:**

**a.** Disconnect line pressure hoses (if connected) and return the cylinder and line pressure gauges to zero using $O_2$ flush valve.

**b.** Open the $O_2$ cylinder, and check for pressure.

**c.** Close the $O_2$ cylinder and observe the pressure gauge for evidence of high-pressure leaks.

**d.** Press the $O_2$ flush valve to empty the piping.

**e.** A typical full $O_2$ cylinder's pressure is 1900 psi. Replace the cylinder if its pressure is less than 1000 psi.

**f.** Reopen the cylinder.

**6. Check nitrous oxide ($N_2O$) cylinder supply:**

**a.** Disconnect line pressure hoses (if connected) and return the cylinder and line pressure gauges to zero using the flow control knobs.

**b.** Open the $N_2O$ cylinder, and check for pressure.

**c.** Close the $N_2O$ cylinder and observe the pressure gauge for evidence of high-pressure leaks.

**d.** A typical full $N_2O$ cylinder's pressure is 745 psi. Replace the cylinder if its pressure is less than 600 psi.

**e.** Reopen the cylinder.

**7. Check AIR cylinder supply:**

- **a.** Disconnect line pressure hoses (if connected) and return the cylinder and line pressure gauges to zero using the flow control knobs.
- **b.** Open the AIR cylinder, and check for pressure.
- **c.** Close the AIR cylinder and observe the pressure gauge for evidence of high-pressure leaks.
- **d.** A typical full AIR cylinder's pressure is 1900 psi. Replace the cylinder if its pressure is less than 1000 psi.
- **e.** Reopen the cylinder.

**8. Power up the system and follow the on-screen prompts to perform the Leak and Compliance Tests.**

**9. Test Flowmeters:**

- **a.** Check that all floats are at the bottom of the flow tubes with the flow control valves closed.
- **b.** Adjust the flow of all gases through their full range and check the floats for erratic movements.

**10. Test Hypoxic-Guard System:**

**For -01 units:**

- **a.** Attempt to create hypoxic $O_2$/ $N_2O$ mixture by slowly opening the $N_2O$ Flow Control Valve.
- **b.** Continue to increase the $N_2O$ flow and observe $O_2$ and $N_2O$ rise in proportion to maintain a minimum concentration of 21% $O_2$ in fresh gas.

**For -02 units:**

- **a.** Attempt to create hypoxic $O_2$/ $N_2O$ mixture by opening the $N_2O$ flow control valve completely.
- **b.** Increase the $O_2$ flow and observe $O_2$ and $N_2O$ rise in proportion to maintain a minimum concentration of 21% $O_2$ in fresh gas.

**11. Test Line Pressure Gas Supplies:**

- **a.** Inspect the supply hoses (should not be cracked or worn).
- **b.** Connect the supply hoses, verifying correct color coding.
- **c.** Adjust both the $O_2$ and $N_2O$ flows to at least mid-range.
- **d.** Verify that the $O_2$ and $N_2O$ supply pressures hold (45–55 psi).
- **e.** Shut off the $O_2$ and $N_2O$ flow control valves.
- **f.** Adjust the AIR flow to at least mid-range.
- **g.** Verify that the AIR supply pressure hold (45–55 psi).
- **h.** Shut off the AIR flow control valve.

**12. Accessories Connection:**

- **a.** Connect a breathing circuit to the Breathing System.
- **b.** Connect a breathing bag to the bag arm.

**13. Check Unidirectional Valves:**

**a.** Set the Ventilation mode to **STANDBY**.

**b.** Set the APL Valve to **20** $cmH_2O$

**c.** Attach a test lung to the Y-fitting of the breathing circuit.

**d.** Set the AIR flow to 5 L/min.

**e.** Press the $O_2$ Flush Valve to fill the breathing bag with volume.

**f.** Slowly squeeze the breathing bag once every 10 seconds.

**g.** Verify that the test lung inflates and deflates.

**h.** Verify that the inspiratory unidirectional valve opens when the test lung inflates.

**i.** Verify that the expiratory unidirectional valve opens when the test lung deflates.

**14. Test drive gas pressure failure system:**

**a.** Set the $O_2$, $N_2O$, and AIR gas flows to mid-range using the flow control knobs.

**b.** Close the $O_2$ gas cylinder using the Tank Wrench.

**c.** Verify that the $O_2$ and $N_2O$ flows fall to zero.

**d.** Verify that:

- An alarm tone sounds.
- The alarm message **$O_2$ Supply Failure** is displayed on the screen.

**e.** Open the $O_2$ gas cylinder. Verify that the alarm tone stops and the alarm message is removed from the screen.

**f.** Close all gas cylinders.

**g.** Remove the $O_2$ cylinder from the **AS3000**.

**h.** Verify that:

- An alarm tone sounds.
- the alarm message **$O_2$ Supply Failure** is displayed on the screen.

**i.** Shut off all flow control valves.

**15. High Pressure Leak Test:**

**a.** Connect a breathing circuit and breathing bag to the Breathing System.

**b.** Set APL Valve to **70** $cmH_2O$.

**c.** Connect the breathing circuit Y-fitting to the test port on the **AS3000**.

**d.** Inflate breathing bag by pressing the $O_2$ Flush Valve until the pressure gauge reaches 40 $cmH_2O$.

**e.** Verify that breathing circuit holds pressure for a minimum of 10 seconds.

**16. Test the Ventilator in STANDBY mode:**

**a.** Set the APL Valve to **20** $cmH_2O$.

**b.** Attach a test lung to the breathing circuit Y-fitting.

**c.** Set the AIR flow to 5 L/min.

**d.** Press the $O_2$ Flush Valve to fill the breathing bag with volume.

**e.** Squeeze the breathing bag once every 10 seconds.

**f.** Verify that the test lung inflates and deflates.

**g.** Set the APL Valve to the open position (**SP**) and stop squeezing the breathing bag.

**17. Test the Ventilator in MANUAL mode:**

**a.** Set the ventilation mode to **MANUAL**.

**b.** Set the APL Valve to **20** $cmH_2O$.

**c.** Set the AIR flow to 5 L/min.

**d.** Squeeze the breathing bag once every 10 seconds.

**e.** Verify that the test lung inflates and deflates to approximately 20 $cmH_2O$ pressure.

**f.** Verify that tidal volume, resp. rate, minute volume, and PEEP values appear on the screen.

**g.** Verify that the $FiO_2$ reading is approximately 21.

**h.** Verify a pressure waveform appears on the screen along with the bag compressions.

**i.** Set the APL Valve to the open position (**SP**) and stop squeezing the breathing bag.

**18. Test the Tidal Volume in CMV mode:**

**a.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**b.** Set the ventilator controls to:

| ATTRIBUTE | SETTING |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | CMV |
| Tidal Volume - $\mathbf{V_T}$ | 600 |
| Breathing Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| Plateau - $\mathbf{T_P}$ | 10 |
| PEEP - **PEEP** | OFF |

**c.** Select **CMV** to begin ventilation.

**d.** Verify that the Tidal Volume display is within 15% of the set value within 5 breaths.

**e.** Verify that the $O_2$ display reads greater than 95% within 5 minutes.

**19. Test the Tidal Volume in the PCV ventilation mode:**

**a.** Set the $O_2$ flow to 2 L/min and set the $N_2O$ and AIR flow rates to minimum flow.

**b.** Set the ventilator controls to:

| ATTRIBUTE | SETTING |
|---|---|
| Patient Type | Adult |
| Ventilation Mode | PCV |
| Target Pressure - $\mathbf{P_{TARGET}}$ | 20 |
| Breathng Rate - **freq** | 8 |
| I:E Ratio - **I:E** | 1:2 |
| PEEP - **PEEP** | Off |
| Inspiratory Slope - **Tslope** | 0.5 |

**c.** Select **PCV** to begin ventilation.

**d.** Verify that the PEAK Pressure settles within ±4 of the set value within 3 breaths.

**e.** Re-activate **CMV** ventilation mode.

**20. Low $\mathbf{FiO_2}$ Alarm Test**

**a.** Set the low $FiO_2$ Alarm limit to 50% $O_2$.

**b.** Set the AIR flow control valve to 5 L/min.

**c.** Set the $FiO_2$ flow controller to minimum flow.

**d.** Verify the following Low $FiO_2$ alarm signals activate, within three ventilation cycles:

- **Low $\mathbf{FiO_2}$** message appears on the screen.
- An alarm tone sounds.

**e.** Set the Low $FiO_2$ alarm limit to 18%.

- Verify the alarm signals stop activating.

**21. High $\mathbf{FiO_2}$ Alarm Test**

**a.** Set the high $FiO_2$ Alarm limit to 49% $O_2$.

**b.** Set the $FiO_2$ flow control valve to 5 L/min.

**c.** Set the AIR flow controller to minimum.

**d.** Verify the following High $FiO_2$ alarm signals activate:

- **High $\mathbf{FiO_2}$** message appears on the screen.
- An alarm tone sounds.

**e.** Set the high $FiO_2$ alarm limit to the max setting.

- Verify the alarm signals stop activating.

**22. High and Low PAW Alarm Test**

**a.** Set the PAW low alarm to the lowest setting.

**b.** Set the PAW high alarm limit set point about 5 to 8 digits below the Peak Pressure displayed on the upper left of the screen.

**c.** Verify the following (high) peak pressure alarms activate:

- **High Airway Pressure** message appears on the screen.
- An alarm tone sounds.
- Inspiration ends and expiration begins as the pressure meets the high alarm limit.

**a.** Set the PAW high alarm limit set point to 65 ($cmH_2O$).

**b.** Verify the alarms signals cease.

**c.** Set the PAW low alarm limit set point to 50 ($cmH_2O$).

**d.** Verify the following (low) peak pressure alarms activate:

- L**ow Airway Pressure** message appears on the screen.
- An alarm tone sounds.

**a.** Set the PAW low alarm limit to 12 ($cmH_2O$).

**b.** Verify the alarm signals cease.

**23. Low MV and APNEA Alarm Test**

**a.** Set the PAW low alarm to the lowest setting.

**b.** Set the PAW high alarm limit set point about 5 to 8 digits below the Peak Pressure displayed on the upper left of the screen.

**c.** Verify the following (high) peak pressure alarms activate:

- **High Airway Pressure** message appears on the screen.
- An alarm tone sounds.
- Inspiration ends and expiration begins as the pressure meets the high alarm limit.

**d.** Set the PAW high alarm limit set point to 65 ($cmH_2O$).

**e.** Verify the alarms signals cease.

**f.** Set the PAW low alarm limit set point to 50 ($cmH_2O$).

**g.** Verify the following (low) peak pressure alarms activate:

- **Low Airway Pressure** message appears on the screen.
- An alarm tone sounds.

**h.** Set the PAW low alarm limit to 12 ($cmH_2O$).

**i.** Verify the alarm signals cease.

**j.** Press the **MANUAL/AUTO** key.

**k.** After 60 seconds, verify that:

- An alarm tone sounds.
- the alarm message “APNEA” is displayed on screen.

**24. Place the system in STANDBY mode.**

**25. Check for appropriate level of patient suction.**

**26. Check, connect, and calibrate other electronic monitors.**

**27. Turn on and set other appropriate alarms for equipment to be used.**

**NOTE: The following step should be performed every 3 days or when prompted by the machine.**

**28. Perform the Oxygen Sensor Calibration (Refer to section 6.8.4.6 (pg. 6-22) ''Oxygen Sensor Calibration'').**

**NOTE: The following step should be performed weekly or whenever a new vaporizer is installed or when $CO_2$ absorbent is replaced.**

**29. Test for leaks in the machine and vaporizers by performing the High Pressure Leak Test as described in step 15 of this section.**

# 6.11 Phone Numbers and How To Get Assistance

A network of service representatives and factory-trained distributors is available. Prior to requesting service, perform a complete operational check of the instrument to verify proper control settings. If operational problems continue to exist, contact the Service Department at (800) 288-2121, ext: 8116 for Technical Support or (201) 995-8000 for assistance in determining the nearest field service location.

Please include the instrument model number, the serial number, and a description of the problem with all requests for service.

Warranty questions should be directed to a local representative. A list of offices, along with their phone numbers, is provided at the end of this manual.

**Upon request, calibration instructions or other information will be provided to assist the user's appropriately qualified technical personnel in repairing those parts of the AS3000 which are designated as repairable.**

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# 7.0 *Warranty*

## 7.1 Warranty Statements

Mindray DS USA, Inc. warrants that components within the anesthesia system will be free from defects in workmanship and materials for the number of years shown on the invoice. Under this extended warranty, Mindray DS USA, Inc. will repair or replace any defective component at no charge for labor and/or materials. This extended warranty does not cover consumable items such as (but not limited to) batteries and external cables.

Recommended preventative maintenance, as prescribed in the Service Manual, is the responsibility of the user, and is not covered by this warranty.

Except as otherwise provided herein, the terms, conditions, and limitations of Mindray DS USA, Inc.'s standard warranty will remain in effect.

Mindray DS USA, Inc. warrants that its products will be free from defects in workmanship and materials for a period of one (1) year from the date of purchase except that disposable or one-time use products are warranted to be free from defects in workmanship and materials up to a date one year from the date of purchase or the date of first use, whichever is sooner. This warranty does not cover consumable items such as, but not limited to, batteries, external cables, sensors, cuffs, hoses, or mounts.

Mindray DS USA, Inc. will not be liable for any incidental, special, or consequential loss, damage, or expense directly or indirectly arising from the use of its products, liability under this warranty and the buyer's exclusive remedy under this warranty is limited to servicing or replacing at Mindray DS USA, Inc.'s option at the factory or at an authorized distributor, any product which shall under normal use and service appear to the Company to have been defective in material or workmanship.

No agent, employee, or representative of Mindray DS USA, Inc. has any authority to bind Mindray DS USA, Inc. to any affirmation, representation, or warranty concerning its products, and any affirmation, representation or warranty made by any agent, employee, or representative shall not be enforceable by buyer.

This warranty is expressly in lieu of any other express or implied warranties, including any implied warranty or merchantability or fitness, and of any other obligation on the part of the seller.

Damage to any product or parts through misuse, neglect, accident, or by affixing any non-standard accessory attachments or by any customer modification voids this warranty. Mindray DS USA, Inc. makes no warranty whatever in regard to trade accessories, such being subject to the warranty of their respective manufacturers.

A condition of this warranty is that this equipment or any accessories which are claimed to be defective be returned when authorized, freight prepaid to Mindray DS USA, Inc., Mahwah, New Jersey 07430. Mindray DS USA, Inc. shall not have any responsibility in the event of loss or damage in transit.

Calibration may be performed without the need to disassemble the instrument. It is the responsibility of the purchaser to perform calibration as necessary, in accordance with the instructions provided in this manual.

## 7.2 Disclaimers

### 7.2.1 Product Improvements

Mindray DS USA, Inc. retains the right to modify the machine and/or operating instructions without prior notification. These operating instructions explain all features of the **AS3000** system and are correct at time of manufacture. Instructions and models produced at a later stage, may contain improvements or modifications that were not included in previous models.

## 7.3 Manufacturer's Responsibility

The effects on safety, reliability, and performance of the equipment are the manufacturer's responsibility only if:

- **a.** assembly operations, extensions, readjustments, modifications or repairs are carried out by authorized personnel; and
- **b.** the electrical installation of the relevant room complies with the appropriate requirements; and
- **c.** the equipment is used in accordance with the instructions for use

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